Segmental Phonology of Xuzhou Mandarin

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Abstract

This thesis examines segmental phonology of Xuzhou dialect, one of Chinese Mandarins spoken in the northern Jiangsu Province of China. I investigate phonological patterns in mono-syllabic words and focus on three aspects of Xuzhou phonology. I adopt the framework of Optimality Theory (Prince and Smolensky 1993) to account for the phonological generalizations.

The phonemic vowel and consonant inventories are proposed. Identification of allophonic relations between segments is based on phonetic similarities and complementary distributions. The study of nasal vowels also draws evidence from the nasal coda origin in Middle Chinese and the parallel /VN/ pattern in modern Standard Chinese. Apical "vowels" are classified as syllabic approximants with support from their articulatory properties and phonotactic behaviors. Palatals and velars are decided to be variants of the same phonemes owing to alternating patterns in semi-onomatopoeic words and literary-colloquial readings.

Phonotactic generalizations are drawn and explained. Co-occurrence restrictions act on height, roundedness and backness of vowels, and on labial, coronal and dorsal articulators of consonants. Restrictions are found between Nucleus and Coda, between Medial and Nucleus, and between Onset and Medial/Nucleus. Typologically marked and unmarked segments exhibit distinctive phonotactic behaviors, which meet cross-linguistic findings. I demonstrate that the universal and violable constraints take effect in co-occurrence restrictions. The undominated ranking of markedness constraints explains systematic gaps in Xuzhou phonotactics. The interactions between faithfulness and markedness constraints account for alternating forms.

Morpho-phonemic alternations under diminutive suffixation are identified and explained. Alternations are operated through basic suffixation, vowel retraction, vowel insertion, vowel nasalization, coda deletion and coda contraction. I argue that constraints force on co-occurrences betweens stems and the suffix, and propose crucial constraint rankings to account for the surface forms of suffixed words. Moreover, phonological opacities are identified in Xuzhou diminutive suffixation. I adopt the sympathy theory within the framework of OT to make an account.

中文提要

徐州方言属于汉语官话方言，分布在中国江苏省北部。本文研究徐州方言的音段音系学，以单音节词为语料，考察徐州音系的三个方面。作者将以优选论为理论框架，解释本文总结的音系规律。

首先，本文研究徐州音系的元音音位系统及辅音音位系统，主要以语音相似性及互补分布原则确认音位变体的关系。此外，从中古汉语的鼻音韵尾和现代汉语普通话的“元音+鼻音”搭配模式寻找线索，考察徐州的鼻元音；并从发音原理及声韵搭配的角度考虑，将传统的舌尖“元音”认定为自成音节的近音；还从半拟声词及文白异读中硬腭辅音和软腭辅音的交替出现类型，判定两者互为音位变体。

其次，本文总结徐州单音节词的声韵搭配规律并提出解释。音段的共现限制涉及元音的舌位高低、前后和圆唇与否，辅音的唇音、前舌音和舌背音。共现限制存在于韵核与韵尾间，介音与韵核间，以及声母与介音或韵核间。类型学中有标记的和无标记的音段表现出不同的声韵搭配行为，这与跨语言的研究结果一致。分析表明，具有普遍性及可以违反的制约条件在共现限制中起作用。排列层级高的标记性制约条件使得声韵搭配中出现系统空缺；忠实性制约条件与标记性制约条件的交互作用产生了音段音变现象。

最后，本文还考察徐州方言的小称音变。作者观察到六种音变过程，包括添加词缀、后缩元音、插入元音、鼻化元音、删除韵尾及合并韵尾。作者认为制约条件在词干与词缀间起作用，并提出生成徐州小称词表层形式的关键层级排列。此外，作者在徐州方言的小称音变中发现音系不透明现象，并采用优选论框架下的和应理论作出解释。

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Chapter 1 Introduction

In Chinese dialectology, descriptions of sound inventories based on auditory impressions or instrumental reports have seen fruitful achievements (Li 1999, Lin and Wang 1992, Su and Lü 1996, Zhou and Wu 1963, among others). Thorough phonological analyses are desired to unveil the organization and interaction of sounds. This thesis makes the first attempt to investigate the segmental phonology of one of Chinese dialects *Xuzhou Mandarin*.

1.1 Goal of the thesis

Xuzhou Mandarin is a Chinese dialect spoken in the northern Jiangsu province of China. In terms of Geographical Dialect Continuum (Chambers and Trudgill 1998), it is at the border of *Zhongyuan* and *Jianghuai Mandarins* (Zhang and Wu 1992, He 2005). The crucial factor to categorize it into the *Zhongyuan* subgroup of the *Mandarin Group* is the loss of the entering tone (Bao and Yan 1985, Liu 2007).

The current study aims to explore the segmental phonology of Xuzhou. It is going to identify the phonemic inventories of vowels and consonants, find out phonotactic restrictions in mono-syllabic words, and draw generalizations on morpho-phonemic alternations.

1.2 Significance of the thesis

The current study has significance in the following two aspects. First, it does a comprehensive and systematic analysis of Xuzhou Mandarin. The phonological study of Zhongyuan Mandarin subgroup has not been rich in the literature. Documented works usually focus on special issues. The present thesis makes effort to study all three aspects of Xuzhou segmental phonology and exhaust the related issues. The findings will enrich the knowledge of Xuzhou and deepen the understanding of Zhongyuan.

Second, certain phonological issues in Xuzhou are discussed with reference to other Chinese dialects. Cross-dialectal similarities and divergences are identified. The phonological generalizations in Xuzhou are explained by the Optimality Theory. OT provides the explanation by re-ranking a set of constraints which have successfully accounted for similar or different observations in other Chinese dialects. The current work will shed light on cross-dialectal studies.

1.3 Data collection

Xuzhou Mandarin has internal diversities which are highly related to the geographic factor of speech communities and the age factor of speakers. Urban speakers' accent has noticeable difference from those of rural areas. Middle-aged or elder citizens are not or less affected by Standard Chinese than younger generations. Other factors such as educational backgrounds or social status are far less influential.

Data are mainly collected from Su and Lü (1996). It is *Dictionary of Xuzhou Dialect*, one of the series of *Modern Chinese Dialect Dictionaries* (Li 1999). This dictionary is developed from fieldwork reports. Informants were male urban citizens in their middle or senior age. (Su and Lü 1996:8-9)

Additionally, contemporary studies of Xuzhou Mandarin documented in Zhang et al. (1984, 1985) and Li (1985) are taken as resources to verify, confirm and enrich the data, because these works focus on the urban accent of the old generation. The collection also includes data from Qiao (1999, 2002) and Mao (2003) which show interests in special topics of Xuzhou sounds. Since I am a native speaker, my own language is occasionally used to make a supplement.

1.4 Theoretical framework

The Optimality Theory (Prince and Smolensky 1993) is adopted to account for phonological generalizations drawn in Xuzhou mono-syllabic words. OT is a linguistic model which proposes that output forms of Language result from constraint interactions. Constraints are universal and violable. Different constraint rankings give rise to grammars of different languages. Surface forms of a language are optimal outputs that minimally violate higher-ranked constraints.

1.4.1 The architecture of OT

The OT grammar is an input-output mechanism. It can be schematically represented in (1). Generator (*Gen*) is a function that takes the input and returns an infinite set of output candidates. Evaluator (*Eval*) is a function that evaluates all candidates and selects the optimal output which best satisfies a set of ranked constraints.

(1) *Grammar as an input-output mechanism* (Kager 1999:19)

***Gen* (input)** $\Rightarrow$ $\{cand_1, cand_2 \ldots cand_n\}$
Eval $\{cand_1, cand_2 \ldots cand_n\}$ $\Rightarrow$ **output**

Eval has two types of constraints. One is MARKEDNESS constraints which enforce structural well-formedness of outputs. They prohibit structures that are difficult to produce or to perceive. Markedness constraints only take outputs into account. The other is FAITHFULNESS constraints which require preservation of inputs. Faithfulness constraints consider both inputs and outputs.

Constraints are ranked. Higher-ranked constraints dominate lower-ranked constraints. Dominance relations are transitive. If Constraint-$_A$ outranks Constraint-$_B$ and Constraint-$_B$ outranks Constraint-$_c$, then Constraint-$_A$ outranks Constraint-$_c$ (Kager 1999:21). Violation of higher-ranked constraints is fatal. Other things being equal, multiple violations are fatal compared with a single violation of the same constraint.

The basic concepts of the OT grammar can be instantiated by the tableau in (2). It analyzes neutralization of voicing contrast in Dutch. Dutch does not have voicing contrast in word-final obstruents.

(2) Neutralization of voicing contrast in Dutch (Kager 1999:16)

Input: /bɛd/	*VOICED-CODA	IDENT-IO(voice)
a. ☞ [bɛt]		*
b. [bɛd]	*!	

The candidates (a.) and (b.) are generated by GEN. The constraint ranking *VOICED-CODA >> IDENT-IO(voice) is a fragment of EVAL. The constraint on the left-hand of the symbol '>>' outranks the constraint on the right-hand. *VOICED-COD is the markedness constraint that disallows a voiced obstruent at the coda position, whereas IDENT-IO(voice) is the faithfulness constraint that requires preservation of the voicing feature. Two constraints are conflicting. The markedness constraint favors candidate (a.), whereas the faithfulness constraint favors candidate (b.).

The domination of the markedness constraint over the faithfulness constraint is strict. Violation of *VOICED-CODA is fatal but violation of IDENT-IO(voice) is tolerable. Candidate (b.) has a voiced obstruent coda. It incurs fatal violation and is ruled out. Candidate (a.) changes the input feature from voiced to voiceless. It satisfies the higher-ranked constraint at the expense of violating the lowered-ranked constraint. Because of strict domination, (a.) is selected.

Constraints are universal. The same set of constraints with a different ranking can be used to explain preservation of voicing contrast in English. English has both voiced and voiceless obstruents at the coda position. The tableau is illustrated in (3).

(3) Preservation of voicing contrast in English (Kager 1999:17)

Input: /bɛd/	IDENT-IO(voice)	*VOICED-CODA
a. [bɛt]	*!	
b. ☞ [bɛd]		*

The constraints are reversely ranked in English. The faithfulness constraint overrides the markedness constraint. The voicing feature must be preserved even

though a voiced obstruent coda occurs. Candidate (a.) changes the voicing feature and incurs fatal violation of IDENT-IO(voice). Candidate (b.) satisfies the higher-ranked faithfulness constraint and wins over candidate (a.).

1.4.2 OT in the thesis

The rationale of using OT to analyze Xuzhou segmental phonology is presented in this section. I will briefly introduce its adequacy to account for Xuzhou phonological generalizations and the theoretical superiority. Detailed will be illustrated in Chapter 4 and Chapter 5.

OT is adequate to offer an explanation to co-occurrence restrictions. Co-occurrence restrictions refer to limitations on sounds and sound sequences. The sound patterns that do not have an articulatory or perceptual basis are not empirically attested. The markedness constraints in OT require output forms to meet some criterion of structural well-formedness. When the constraints are undominated, any co-occurrence that violates them will be ruled out from the language. An example from Xuzhou is non-cooccurrences of velar consonants with adjacent high front vowels. The undominated markedness constraint *VELAR-I in EVAL of the grammar eliminates syllables such as *[ki].

OT is adequate to offer an explanation to segmental alternations. Alternating forms are realized from interactions of universal and violable constraints. Markedness and faithfulness are inherently conflicting (Kager 1999:6). The constraint ranking determines output forms. The grammar of markedness constraints over faithfulness constraints will produce an alternating form of the input which does not meet structural well-formedness. Palatalization of velar consonants in Xuzhou provides a concrete example. The tableau is illustrated in (4).

(4) Palatalization in Xuzhou

Input: /ki/	*VELAR-I	IDENT-IO(place)
a. [ki]	*!	
b. ☞ [tɕi]		*

In Xuzhou, palatals alternate with velars. They are in complementary distribution. Velars never co-occur with a following high front vowel or glide. It is under the pressure of the markedness constraint *VELAR-I. (4a.) is a failed candidate because the markedness constraint is higher-ranked and the violation is fatal. On the contrary to velars, Palatals only occur before high front vowels or glides. The alternation in (4b.) changes the place feature. It militates against the faithfulness constraint IDENT-IO(place) which requires preservation of the place feature. (4b.) is selected because it satisfies the higher-ranked constraint *VELAR-I. The violation of the lower-ranked constraint IDENT-IO(place) is tolerable. This example shows that constraint interactions can successfully account for segmental alternations.

OT is superior to rule-based theories. The rule-based theories have two problems. One is the rule conspiracy. The rule-based theories state that phonological rules are uniformed only when they have structural similarities. The functional unity of rules is overlooked. The other is the duplication problem. Morpheme-structure rules are distinguished from phonological rules. Two rules that carry the same information need to be invoked if they apply in different linguistic propers. It causes reduplication. OT avoids the problem of rule conspiracy because it recognizes the functional unity of phonological processes by constraints. OT does not have the duplication problem since morphological well-formedness constraints are ranked in a single hierarchy with phonological well-formedness constraints.

OT is superior to the constraint-and-repair theories. The constraint-and-repair theories introduce surface-unviolated constraints to trigger or block the application of rules. Co-existence of constraints and rules cause theoretical complexity. The phonological status of rules is doubted because their application is only in response to constraints. OT can do the job of constraint-and-repair theories and it offers a simpler theoretical model. OT limits grammatical interactions to constraints only. It does not demand rules. The GEN function in the grammar provides all structures. The EVAL function evaluates the structures and selects the optimal one as output. The constraint ranking in EVAL takes full responsibility for surface forms. In this regard, OT is conceptually advanced.

1.5 Organization of the thesis

The thesis consists of six chapters. They are organized as follows. Chapter 1 introduces the basics. It states the goal and significance of the thesis, describes methodology of data collection and introduces the theoretical framework.

Chapter 2 examines the phonological system of Xuzhou. It begins with an overview of Xuzhou speech sounds. The issues of apical vowels and palatal consonants in Standard Chinese are reviewed and discussed. The main body is devoted to the study of Xuzhou phonemic inventories. Contrastive segments are identified by evidence of minimal pairs. Allophonic relations are proposed on the bases of phonetic similarities and complementary distributions.

Chapter 3 studies the phonotactics of Xuzhou. The phonological status of pre-nuclear glides in Standard Chinese is reviewed and discussed. It enlightens the study of Xuzhou syllable structure. The focus of this chapter is segmental co-occurrences and non-cooccurrences in Xuzhou monosyllabic words. Systematic gaps are distinguished from accidental gaps with justification. Generalizations on phonotactic patterns are drawn.

Chapter 4 provides an optimality-theoretic account for Xuzhou phonotactic generalizations. Undominated markedness constraints are identified to explain systematic gaps. Interactions of markedness and faithfulness constraints provide an account for segmental alternations and the preservation of typologically unmarked segments.

Chapter 5 investigates morpho-phonemic alternations under Xuzhou diminutive suffixation. Morpho-phonemic processes are identified based on the generalizations of alternating forms. After the review and discussion of different theoretical models, the alternations in Xuzhou are explained within the framework of OT.

Chapter 6 concludes the thesis. It summarizes the main findings and arguments, states the contributions, and presents limitations in hope of improvements in future studies.

Chapter 2 Phonemic inventories

This chapter discusses phonemic inventories of Xuzhou sounds. It begins with a general introduction of Xuzhou dialect and reviews previous studies on the phonological system of Standard Chinese. The main body is dedicated to phonemic inventories of Xuzhou vowels and consonants. The phonological system of this language is proposed in the end.

2.1 Background of Xuzhou dialect

This section introduces the classification of Xuzhou dialect in Chinese languages and its phonetic inventories of vowels, consonants and tones. The dialectal affiliation to the *Mandarin* family of Xuzhou is a prerequisite to the following literature review on Standard Chinese, and the introduction of speech sounds paves the way for the discussion of phonemes.

2.1.1 Dialectal classification

The classification of Chinese dialects is based on their idiosyncratic characteristics (Zhan 2002). Both diachronic and synchronic methods are employed to make the delimitation and classification. Linguists take the assumption that Modern Chinese evolved from Middle Chinese which had developed from Old Chinese. A well-adopted technique is to compare the dialects with *Qieyun* ('cutting rimes'), a dictionary that was published in 601 A.D. and introduced rimes of Middle Chinese (Zhan 2002). Since the ultimate goal is to identify varieties of contemporary Chinese languages, results of cross-dialectal studies are decisive.

Modern Chinese are classified into SUPERGROUPS[1] (Li 1989, CASS and AAH 1989, Zhan 2002, Xiong and Zhang 2008). They are *Mandarin*, *Wu*, *Xiang*, *Gan*, *Hakka*, *Cantonese*, *Min*, *Jin*, *Hui*, *Ping and Tu*[2](Xiong and Zhang 2008). The term

[1] The term 'supergroup' and 'group' are adopted in accordance with the English version of *The Language Atlas of China* (CASS and AHH 1989), which are used to show delimitation hierarchies.
[2] *Tu* is newly classified in *The Language Atlas of China* (CASS *forthcoming*). It was identified but left ungrouped in the old edition (CASS and AHH 1989).

Mandarin used in this paper refers to a branch of Northern Chinese. This family includes eight groups, namely, *Jianghuai* ('Yangtze'), *Xi'nan* ('Southwestern'), *Zhongyuan* ('Central Plain'), *Lanyin* ('Northwestern'), *Dongbei* ('Northeastern'), *Jilu* ('Northcentral'), *Jiaoliao* ('Peninsular') and *Beijing*. I am not going to introduce specific criteria and linguistic characteristics of each group, because they are peripheral to the current study. Details can be found in Li 1989, CASS and AAH 1989, Zhan 2002, Xiong and Zhang 2008, among others.

Xuzhou dialect is one of the *Zhongyuan Mandarins* spoken in the northern Jiangsu province of China. The speech community resides in Xuzhou city and the surrounding counties. In terms of Geographical Dialect Continuum (Chambers and Trudgill 1998), Xuzhou is at the border of *Zhongyuan* and *Jianghuai Mandarins* (Zhang and Wu 1992, He 2005). The crucial factor to categorize Xuzhou into *Zhongyuan* is the loss of the entering tone (Bao and Yan 1985, Liu 2007).

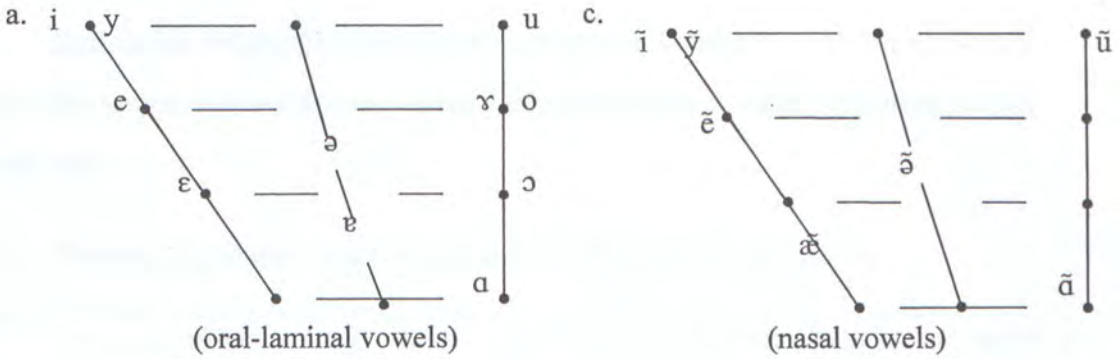
2.1.2 Phonetic inventories

Previous studies of Xuzhou dialect mainly focus on collection and identification of sounds in speech (Zhang et al. 1984, 1985; Li 1985; Su and Lü 1996), and on comparison between Xuzhou and Standard Chinese (Su 2002). The achievements are notable. An entire picture of speech sounds has been worked out and is to be introduced below.

2.1.2.1 Vowels

Vowels in Xuzhou are distinguished along three dimensions: backness, height and roundedness. Nasality and laminal-apical distinction are also in effect of making contrasts, and consequently enrich the sound system. (1) presents a complete phonetic vowel inventory.

(1) *Phonetic vowel inventory* (Su and Lü 1996)



(1a.) is a chart of Xuzhou oral-laminal vowels and the display is based on Daniel Jones's vowel quadrilateral. Backness has a three-way distinction, with the slant line in the chart denoting *front*, the approximal vertical line for *central* and the vertical line for *back*. Thus this language has front vowels [i, y, e, ɛ], central vowels [ə, ɐ] and back vowels [u, ɤ, o, ɔ, ɑ]. Vowels of the same backness value differ in height. Three-way distinction of *high*, *mid* and *low* separates high vowel [i, y] from mid vowel [e, ɛ], mid vowel [ə] from low vowel [ɐ], and high vowel [u], mid vowel [ɤ, o, ɔ] from low [ɑ]. Lip-rounding is a third concern on vowel distinction. The left side of the slant/ approximal-vertical/ vertical lines lists *unrounded* vowels while the right side lists *rounded* ones. Two pairs of sounds are distinct only in roundedness: unrounded [i] versus rounded [y], and unrounded [ɤ] versus rounded [o].

(1b.) presents three oral-apical vowels in Xuzhou. The place of articulation of [ɿ] is close to that of the dental consonants [ts, ts^{h}, s], and the place of articulation of [ʅ] is close to that of the retroflex consonants [tʂ, tʂ^{h}, ʂ, ɻ]. *Fangyan Diaocha Zibiao*, 'a dialect investigator's handbook' (CASS 2005:81) describes [ɿ] and [ʅ] in Chinese languages as *high front unrounded apical* vowel and *high back unrounded apical* vowel respectively. This will be verified in the current study. [ɚ] is a rhotic vowel.

(1c.) displays nasal vowels. [ẽ] and [æ̃] are found in open syllables. [ĩ, ỹ, ũ, ə̃, ɑ̃] never occur in open syllables, and they always co-occur with a [-ɻ] coda.

2.1.2.2 Consonants

Xuzhou has twenty-four consonants as presented in the (2). They can be divided into five groups with respect to places of articulation: labial, dental, retroflex, palatal and velar.

(2) *Phonetic consonant inventory* (Su and Lü 1996; with modification)

manner \ place		labial	dental	retroflex	palatal	velar
plosive	unaspirated	p	t			k
	aspirated	p^h	t^h			k^h
affricate	unaspirated		ts	tʂ	tɕ	
	aspirated		ts^h	$tʂ^h$	$tɕ^h$	
fricative	voiceless	f	s	ʂ	ɕ	x
	voiced	v				
nasal		m	n		ȵ	ŋ
liquid			l	ɻ		

Two modifications are made in (2). First, the palatal nasal [ȵ] is added in the table. It is not included in the dictionary, but Su and Lü (1996:4) introduce that when the dental nasal *n* is followed by *Xi Yin* ('narrow sound') [i/j] or [y/ɥ], it becomes palatalized. Since the sound exists in Xuzhou, it is necessary to report it.

Second, the retroflex approximant [ɻ] in (2) replaces the voiced retroflex fricative [ʐ] in the dictionary. Recent works verify that this is an approximant rather than a fricative. Zhu (2007) looks into this sound in Standard Chinese and in many northern dialects. He uses five criteria to distinguish approximants and fricatives: *duration*, *amplitude*, *formants*, *cross-sectional area*, and *turbulent flow*. Evidence from Standard Chinese shows that the sound has shorter duration and weaker amplitude than [ʂ]. In addition, it has formants but [ʂ] does not (Zhu 2007:4, 6-7). These properties designate an approximant rather than a fricative. Zhu also checks through the data in many northern dialects, including Xuzhou (*personal correspondence*), and decides that the sound should be [ɻ] but not [ʐ] in these languages (2007:7). Therefore, [ɻ] is adopted in the current study.

2.1.2.3 Tones

There are four tonal types in stressed mono-syllabic words of Xuzhou. They are the dip-rising tone *213*, the high level tone *55*, the mid rising tone *35* and the high falling tone *51*, exemplified in (3).

(3) *Xuzhou tones in stressed mono-syllabic words* (Su and Lü 1996)

[mɑ^{213}]	[mɑ^{55}]	[mɑ^{35}]	[mɑ^{51}]
'mother'	'hemp'	'horse'	'scold'
妈	麻	马	骂

(3) uses Chao Digits (Chao 1930) for transcription. The pitch range is equally cut into five scales which offer the referential points of pitch movement. *1* and *5* are two polar pitches, *2* is mid-low, *3* is in the middle and *4* is mid-high. [mɑ^{213}] has a complex contour tone that starts from the mid-low pitch, falls to the bottom and then rises to the middle. [mɑ^{55}] has a level tone starting from and holding at the highest pitch all the time. [mɑ^{35}] has a simple contour tone from the middle to the highest pitch, denoting a rising. [mɑ^{51}] also has a simple contour tone encoding a sharp fall from the highest to the lowest pitch.

2.2 Previous studies on phonemic inventories of Standard Chinese

There have been abundant literatures on phonemic inventories of Chinese dialects. This section is going to review the issues relevant to the study of Xuzhou vowels and consonants. I will focus on the literature of Standard Chinese because it belongs to the same dialectal group with Xuzhou, and they have similar phonological patterns in the concerned topics. Works on other Chinese dialects will be addressed whenever relevant.

2.2.1 Concept of *Phoneme*

Phoneme is the smallest unit which contrasts word meanings in the sound system of a language. It is a mental representation and does not exist in reality. Phoneme is recognized in both Structural and Generative phonologies. In his fieldwork on the Canadian Athabaskan language Sarcee, Sapir (1933) reports that his informant would hear sounds that are not present in speech. For instance, the informant insists the difference between *dìní* 'this one' and *dìní* 'it makes a sound', which can not be perceived by Sapir's trained ears. Intuitively, the second word has a word-final *t*. This latent consonant would be realized under suffixation. Another example can be drawn from American English. Most native speakers hear a difference between *t* in "writer" and *d* in "rider" and ignore the difference between vowels. The phonetic study reveals that the consonants are identical whereas the vowel lengths are different (Kenstowicz 1994:6).

Phoneme is a phonological concept. It is abstract. In contrast, *phone* is a concrete phonetic unit and can be heard in speech. One concern of phonology is to determine valid relations between surface phonetic segments and abstract mental constructs (Odden 2005:44). In Standard Chinese, the vowels in [i^{55}] 一 'one' and [u^{55}] 屋 'house' are phonologically contrastive because they distinguish word meanings. The vowels in [an^{51}] 案 'case' and [ɥɛn^{51}] 院 'courtyard' are phonologically identical and the occurrence of [ɛ] is predictable by the preceding glides (Lin 2007:154). In other word, the difference between [i] and [u] are not only

phonetic but also phonemic whereas the difference between [a] and [ɛ] is solely phonetic.

The notion of *phoneme* has not been seriously addressed within the framework of Optimality Theory (Prince and Smolensky 1993). OT hypothesizes that the free combination of linguistic primitives (e.g. phonological features) and the input are identical. The hypothesis is called *richness of the base*, ROTB in short (McCarthy 2002:70). *Input* in OT is universal. It is different from *phoneme* in the classic generative phonology which is a determinate underlying representation for a given output. However, OT has not denied the phonological status of *phoneme*. Learners select the underlying representation by lexicon optimization, and they also make use of surface alternating forms to determine the underlying form (McCarthy 2002:77-78). In other words, the underlying form for a given output is still identifiable in the rich base.

The current study of phonemic inventories follows the classic generative phonology. It differs from the structural phonology by viewing features as the smallest contrastive unit in phonology. The identification of phonemes is mainly based on phonetic similarities and complementary distribution, supplemented by native speaker's intuition and other means. Identifying the phonemic system is important because it paves the way to the subsequent study of segmental alternations. The result will facilitate the OT analysis by narrowing down the infinite inputs to underlying forms that are more harmonic or regulated than others.

2.2.2 Apical "vowels"

Previous works on [ɿ, ʅ] in Standard Chinese are relevant to the study in Xuzhou for at least two reasons. First, both languages belong to the same dialectal group *Mandarin* (Li 1989, Zhan 2002, Xiong and Zhang 2008), and apical vowels are commonly attested across Mandarin dialects (Karlgren 1915-26, trans. by Chao et al. 1962:197). Second, both languages have much likeness regarding distributions of apical vowels in their sound systems. The kinship relation and similarities in

distributional patterns make it feasible and worthy to review the literature of Standard Chinese.

Scholars have agreement on the apical property of [ɿ, ʅ] in Standard Chinese, but they hold different opinions on classification of the two segments and use different notations. The symbols [ɿ, ʅ] are used by people who treat the sounds as vowels, and [z, r] (Duanmu 2000:36) or [ɻ] (Lin 2007:72) are used by those who consider them to be consonants. The nature of the two apical 'vowels/consonants' is under debate. I will not refer to them by 'vowels' or 'consonants' to avoid bias, but refer to the segments by their syllable position, *nuclei*. (4) is a list of proposals and selected works on them. **V** stands for Vowels and **C** for Consonants.

(4) *Proposals for apical nuclei in Standard Chinese and selected works*

Proposals		Selected works
V	Vowels	Karlgren 1915-26; Zhou and Wu 1963; Howie 1976; Lin and Wang 1992
	Vowels which are prolongation of preceding consonants	Chao 1934, 1968
	Vowels which are variants of /i/	Fu 1956; Xu 1957
	Vowels which are variants of /ɿ/	You et al. 1980
	Vowels with independent phonemes /ɿ/ and /ʅ/	Huang and Liao 2002
	Vowels which are variants of /ɨ/, independent of /i/	Cheng 1973
	Vowels which have the same phoneme /ɨ/ with [i]	Hsueh 1986
C	Syllabic consonants which result from prolongation of onset consonants	Duanmu 2000; Lin 2007

In Standard Chinese, [ɿ] only follows dental obstuents [ts], [ts^h] or [s], and [ʅ] only follows retroflexes [tʂ], [tʂ^h], [ʂ] or [ʐ/ɻ][3]. Karlgren (1915-26, trans. by Chao et al. 1962:197) considers the sounds as vowels because little friction is heard during

[3] The symbols [ʐ] and [ɻ] are used in different works. [ʐ] represents the voiced retroflex fricative whereas [ɻ] represents the retroflex approximant. Arguments for [ʐ] or [ɻ] are irrelevant to the current issue and will not be introduced here.

the production. He also reports that their places of articulation are similar to the preceding consonants, and some people do pronounce syllabic [ʐ̩] for [ɿ] or [ʑ̩] for [ʅ]. But only [sʐ̩, tsʐ̩] are found. [ts^{h}ʐ̩] is rarely heard. Chao (1934, in Joos 1957:43; 1968:24) observes similarities between onsets and nuclei, and describes the nuclear segments as vowels that are prolongation of preceding consonants. Zhou and Wu (1963:35) use the X-ray spectroscopy to show that the back of the tongue is raised when producing [ɿ] or [ʅ], and this is close to a vowel articulation. Howei (1976:10-11) is committed to this view "because of the clearly observable formant structures indicating that they are definitely vowels". Li and Wang (1992:43-44) agree that the sounds should be vowels independent of preceding consonants. They argue that [ɿ, ʅ] are widely distributed in Chinese languages, and these two segments do not always co-occur with [ts, ts^{h}, s] or [tʂ, tʂ^{h}, ʂ, ʐ̩/ɻ̩] from a cross-dialectal perspective. Treating [ɿ, ʅ] in Standard Chinese as syllabic embodiment of preceding consonants would isolate them from nuclear sounds in [mɿ] (米) 'rice', or [tɿ] (低) 'low' in other dialects such as *Hefei* in Anhui province or *Fenyang* in Shanxi province, and consequently loses significance of typological studies.[4]

Besides the debates on the nature of [ɿ, ʅ], there exist discrepancies on their roles in the phonological system of Standard Chinese. Fu (1956:11) and Xu (1957:23) propose /i/ to be the phoneme of three variants [ɿ, ʅ, i] because of their complementary distribution and native speaker's intuition. Hsueh (1986:18-20) posits that there is only one high vowel phoneme /ɨ/ for variants of [ɿ, ʅ, i, u, y]. His argument is based on *Si-hu* ('four types of rimes') and rhyming. The theory of *Si-hu* requires rimes of the same type share the same prenuclear glide, and the theory of rhyming requires the rhymed syllables have the same nuclei and codas. To make an account for their appearance in *Si-hu*, *i, u, y* are analyzed as combinations of phonemes /jɨ, wɨ, jwɨ/. Moreover, [i] (衣) 'clothes', [ʂʅ] (尸) 'corpse' and [tɕy] (居) 'residence' are grouped into the same rime type in *Shi-san Zhe* ('thirteen rimes').

[4] One more argument for [ɿ, ʅ] being vowels can be found in Zhu (2008). It defines vowels as syllable nuclear sounds whose production does not induce noticeable constriction in the oral cavity (Zhu 2008:459) and classifies [ɿ, ʅ] as vowels. Since the present thesis does not take syllable positions as criteria to define vowels, I will not elaborate Zhu's work for the time being.

Therefore, Hsueh considers they shall have the same nuclei /ɨ/. On the contrary, Cheng (1973:13-14) suggests [ɿ, ʅ] are phonologically different from [i] with reference to vowel changes in *Er*-suffixation, where changes of [ɿ, ʅ] are similar to that of [u] rather than [i] or [y]. He uses /ɨ/ for the phoneme of [ɿ, ʅ] and /i/ for [i]. Variants of /ɨ/ are determined by the preceding consonants. You et al. (1980:333) regard the apical/laminal distinction as great. They propose an apical vowel phoneme /ɿ/ for [ɿ, ʅ] and /i/ for [i]. Huang and Liao (2002:119) have similar concern but makes further distinction by proposing two phonemes /ɿ/ and /ʅ/ for [ɿ] and [ʅ] respectively.

Although there are various vowel arguments, advocates for apical nuclei being consonants have seen agreement. Duanmu (2000:36-37) considers the two sounds as prolongation of preceding consonants. They are voiced syllabic consonants with little friction, represented by [z] and [r] respectively. The following reasons are provided. First, nuclear [z] and [r] are articulatorily similar to their preceding consonants. Since approximants and obstruents can become syllabic, they are possible to appear as nuclei. Second, these two sounds are articulated "quite different from [i]" (Duanmu 2000:37). Third, they can barely rhyme with each other in poetry, neither do they rhyme with [i]. Following Duanmu, Lin (2007:72) treats the apical nuclei as syllabic consonants and her argument is mainly based on sound production. She describes that when producing the syllable, the tongue tip stays in the same position within the oral cavity from onsets to nuclei, and there is a lesser degree of constriction at the second phase.

Discussions on the apical nuclei in Standard Chinese are summarized in (5). There are two major issues: phonetic nature of the sounds and their phonological representations. Five types of evidence have been used to determine whether they are vowels or consonants, including (i) places of articulation, (ii) listener's perception, (iii) formant structures, (iv) X-ray spectroscopy report, and (v) cross-dialectal data. Studies of their phonological representations show considerations on (i) the distributional patterns, (ii) sound changes under *Er*-suffixation, and (iii) native speaker's intuition, including assignment to *Si-hu* and rhyming patterns.

(5) *Types of evidence in studies of apical nuclei in Standard Chinese*

Issues	Types of evidence
Phonetic nature of apical nuclei: vowels or consonants?	▫ Places of articulation ▫ Listener's perception ▫ Formant structures ▫ X-ray spectroscopy report ▫ Cross-dialectal data
Phonological representations of apical nuclei	▫ Distributional patterns ▫ Sound changes under *Er*-suffixation ▫ Native speaker's intuition i. Assignment to *Si-hu* ii. Rhyming

In general, articulatory properties are the major concern of sound classification and listener's perception also plays an important role. Previous works agree in three aspects. First, the two sounds are produced at the same places with the preceding consonants. Second, the vocal tract is opened wider to eliminate constriction. Third, little friction can be heard. The articulatory properties of the sounds and their syllable position make it reasonable to consider them as vowels or approximants.

The cross-dialect concerns have null influence on classification of the apical nuclei. Chinese dialects are mutually related, but the relationship is built on linguistic phenomena of individual dialects, not vice versa. Whether [ɿ, ʅ] in Standard Chinese are vowels or not is a language-specific issue. The decision shall be made on the basis of this language per se. Apical vowels in other dialects do not necessarily exist in Standard Chinese.

Evidence of formant structures and X-ray spectroscopy are not solely in support of the argument for vowels. Duanmu (2000:37) argues that approximants like [l] has formants as well, and the raise of the tongue back shown in the X-ray study is also true in production of [ts, ts^h, s]. Since formant structures or the dorsal articulation are not unique to vowels, the possibility of apical nuclei being approximants cannot be denied.

Assuming the apical nuclei in Standard Chinese are vowels, a subsequent question is about their phonemes. It is a fact that [ɿ, ʅ] are complementarily distributed with [i], and native speakers feel the three vowels are the same (Fu 1956:11; Xu 1957:23). However, the complementary distribution is not sufficient to determine the allophonic relation of a group of sounds. Phonetic similarities are also necessary determinants.

You et al. (1980:333) and Huang and Liao (2002:119) suggest [ɿ, ʅ] are not variants of /i/ because apical vowels are produced with the tongue tip and laminal vowels are produced with the tongue body. Since the tongue tip and the tongue body are two different articulators, the laminal vowel [i] is phonetically distant from apical nuclei [ɿ, ʅ]. Therefore, I consider [ɿ, ʅ, i] are not allophones of the same phoneme.

Evidence of sound changes under *Er*-suffixation is convincing. During the morpho-phonemic process, [ɿ] or [ʅ] in base words become [əɻ] in derived words, but [i] in base words become [jəɻ] in derived words (Duanmu 2000:196-197; Lin 2007:185). It indicates that the underlying forms of apical nuclei and the laminal vowel are different.

Regarding the use of *Si-hu*, its validity is doubted. Definition of *Si-hu* in Hsueh (1986) is different from that in Wang (1979). According to Hsueh (1986:18), the phonological representations of [i, u, y] shall have the same prenuclear glides with other rimes in the same *Hu*. However, Wang (1979:284-285) does not consider identical pre-nuclear glides necessary and allows the singleton rime /i, u, y/ in their respective rime types. Different definitions cause the use of *Si-hu* unreliable.

Although rhyming evidence can be supportive, Hsueh (1986:18) and Duanmu (2000:37) disagree on whether the apical nuclei rhyme with [i] or not. Hsueh (1986:18-20) draws data from *Shi-san Zhe* ('thirteen rimes') where [i], [ʅ] and [y] are categorized into the same rime type. However, [u] belongs to another rime type in *Shi-san Zhe* (Hsueh 1986:22). Different rime affiliations of [ɿ, ʅ, i, y] and [u] go against Hsueh's one-phoneme argument. Because if [ɿ, ʅ, i, u, y] are allophones of the same vowel /ɨ/ as Hsueh suggests, they shall be able to rhyme with each other and be assigned to the same rime type in *Shi-san Zhe*. Now that Hsueh's proposal is

not empirically grounded, Duanmu's view that [ɿ, ʅ] do not rhyme with [i] is conservative and safe[5].

The above discussions indirectly support that apical nuclei are not vowels. The assumption that apical nuclei are approximants can settle the disputes. First, it is unnecessary for them to have phonetic similarities with the laminal vowel [i]. Second, since they are prolongation of preceding consonants, the nuclear positions of base words are underlyingly vacant. Under *Er*-suffixation, the suffix /-əɻ/ is directly attached to the onsets, which explains the rime [əɻ] in derived words. Third, rimes with syllabic approximants are beyond the scope of *Si-hu* and are not regulated by rhyming patterns. Therefore, I consider that apical nuclei are syllabic approximants which have the same place of articulation with the preceding consonants.

[5] Thanks to Prof. Gu Yang who bought the rhyming patterns in Tang Poetry to my awareness. [ɿ, ʅ] rhymed with [i] in poems composed in the Tang Dynasty (618-907 A.D.). I will not take it as contemporary evidence because language changes over time.

2.2.3 Palatal consonants

In Standard Chinese, palatals [tɕ, tɕʰ, ɕ] are in complementary distribution with dentals [ts, tsʰ, s], retroflexes [tʂ, tʂʰ, ʂ] and velars [k, kʰ, x]. [tɕ, tɕʰ, ɕ] can only occur before high vowels [i, y] or pre-nuclear glides [j, ɥ] whereas the other three cannot. Opinions differ on which series can be identified with palatals or whether palatals are phonologically independent. A list of proposals and selected works are presented in (6).

(6) *Identification of palatals in Standard Chinese and selected works*

Phonemes	Selected works
/ts, tsʰ, s/	Hartman 1944; Hockett 1947; Duanmu 2000, 2007
/tɕ, tɕʰ, ɕ/	Cheng 1973; Wang 1991; Lin and Wang 1992
/k, kʰ, x/	Chao 1934 (in Joos 1957); Hsueh 1986

The retroflex series /tʂ, tʂʰ, ʂ/ are missing from (6). Duanmu (2000:28) considers that this exclusion is "probably due to articulatory ease". When producing a retroflex, the tongue tip is curled back, which physically tends to push back the tongue body. On the contrary, articulation of high front vocoids [i]/[j] or [y]/[ɥ] requires frontness of the tongue body. The two mechanisms are conflicting and cause articulatory difficulty.

The dental series /ts, tsʰ, s/ are proposed in Hartman (1944), Hockett (1947) and Duanmu (2000, 2007). Hartman (1944:121) excludes velars by using the criterion of phonetic similarity. The consonant [ɻ] is interpreted as a semivowel because it can occur either before or after the nucleus. The retroflexes [tʂ, tʂʰ, ʂ] are phonetically similar to combinations of dental series plus the retroflex semi-vowel [tsɻ, tsʰɻ, sɻ], while the palatals [tɕ, tɕʰ, ɕ] resemble the dental series plus the palatal semi-vowel [tsj, tsʰj, sj]. Thus retroflexes and palatals are considered to be allophones of dentals /ts, tsʰ, s/.

Hockett (1947:224) treats [tɕ, tɕʰ, ɕ] as palatalization of /ts, tsʰ, s/, and describes that "these consonants with palatalization are articulated with the tip of the

tongue behind the lower teeth, the frontal surface of the tongue in contact with the upper teeth and the alveolar ridge to produce the closure or friction". He also treats [tʂ, tʂʰ, ʂ] as retroflexation of /ts, tsʰ, s/, and describes that "the tongue retracted and lifted to the roof of the mouth, so that the tip is behind the alveolar ridge, the contact being between an area of the tongue including tip and blade and the roof of the mouth, behind the alveolar ridge".

Duanmu (2007:28) disagrees on the allophonic relation between palatals and retroflexes by reason of articulatory difficulty. Duanmu (2007:31-34) argues that palatals are consonant-glide combinations and have a special relation with dentals [ts, tsʰ, s]. Evidence is drawn from Cao (1987) which reports two varieties of pronunciation among certain speech communities: palatalized dentals [tsʲ, tsʲʰ, sʲ] and palatals [tɕ, tɕʰ, ɕ].

Palatal phonemes /tɕ, tɕʰ, ɕ/ are proposed by Cheng (1973), Wang (1991), and Lin and Wang (1992). Cheng (1973:37) does not see any relations between palatals and the other three "distributionally complementing series", and thus he considers palatals to exist underlyingly. Wang (1991:134-135) and Lin and Wang (1992:201) suggest that, any one of the three series (dentals, retroflexes, and velars) can be possible phonemes of palatals, and it is theoretically difficulty to choose a best. They remain conservative and assume a series of palatal phonemes.

Velar phonemes /k, kʰ, x/ are proposed by Chao (1934) and Hsueh (1986). Chao (1934, in Joos 1957:49) gives due consideration to native speaker's intuition. The informant feels [kə, tɕi, ku, tɕy] or [xə, ɕi, xu, ɕy] are alliterative series with only different vowels. Chao also provides evidence from a secret language, where Initial (I) and Final (F) of a syllable is split and become I of [Iai] and F of [kF] in a new disyllabic word [Iai. kF], e.g. [pei] (北) 'north' > [pai-kei]. But [k] becomes [tɕ] when it is followed by a high front vowel or glide, as in [mi] (米) 'rice' > [mei-tɕi].

Hsueh (1986:33) finds alternations between palatals and velars in semi-onomatopoeia. He reports that the first and the third syllables in many semi-onomatopoeic words have identical onsets. For instance, onsets of the first and

third syllables are both [t] in [ti. li. ta. la] (嘀哩嗒啦). However, when the first syllable has a palatal onset, the third syllable would have a velar onset as correspondent. For example, the onset of the first syllable in [tɕi. li. ka. la] (叽哩嘎啦) is an unaspirated palatal [tɕ], and the onset of the third syllable is an unaspirated velar [k].

The proposals and arguments are briefly summarized in (7). I will discuss them in the following.

(7) *Phonemes of palatals in Standard Chinese and arguments*

Phonemes	Arguments/Crucial examples
/ts, ts^h, s/	▫ Articulatory description of phonetic similarities between dentals and palatals ▫ Alternations between palatalized dentals and palatals in certain speech communities
/tɕ, $tɕ^h$, ɕ/	▫ [tɕ, $tɕ^h$, ɕ] in speech ▫ no relation between [tɕ, $tɕ^h$, ɕ] and other three series of consonants
/k, k^h, x/	▫ Native speaker's feeling of palatals and velars in alliterative series ▫ Alternations between palatals and velars in a secret language ▫ Alternations between palatals and velars in semi-onomatopoeic words

The criterion of phonetic similarity is crucial but its measurement is tricky. It is clear that dentals and palatals are similar in terms of manners of articulation. However, velars are also articulatorily close to palatals because the soft palate and the hard palate are adjacent. Therefore, both dentals and velars are phonetically similar to palatals.

Although there are lots of languages which have palatalized dentals, alternations of palatalized dentals [ts^j, ts^{jh}, s^j] with palatals are drawn from a non-natural language and shall not be supportive. Duanmu (2007:31-34) introduces two varieties of pronunciation for palatals based on the data in Cao (1987). Variety A uses

palatalized dentals and Variety B uses palatals. Thus he suggests there is a link between the two sound classes. However, Cao's reports are sociolinguistic findings. Variety A is common among children, female speakers and some males. The degree of this variety in a single speaker's accent lowers down gradually (Cao 1987:85-86). Cao proposes that influences from southern dialects especially *Wu*, Beijing opera and Standard Chinese prescribed in 1913 could be possible causes. According to Cao (1987:88-90), the accent of palatalized dentals conveys softness and charm recognized by the social value, and this explains why women incline to produce the two varieties. Boys also have such an accent because they are affected by mothers and sisters during the childhood. The degree of palatalized dentals decreases as females get old and males grow up. In other words, the variety of palatalized dentals is made-up and short-lived.

The proposal for /tɕ, tɕ^h, ɕ/ being the phonemes is a conservative strategy, but it runs risky of hedging the question. /tɕ, tɕ^h, ɕ/ shall not be independent phonemes because they never contrast with any of the other three series (Hartman 1944:116). Lacking evidence makes the judgment difficult, but it is an excuse to retreat. Empirically, the proposal for palatal phonemes will not cause confusion of sounds in speech; but theoretically, this is an attitude of not solving the problem (Hsueh 1986:34).

The proposal for the velar phonemes /k, k^h, x/ is better justified than the above two. Native speaker's feeling of alliterative series is convincing. The game in a secret language reflects native speaker's intuition by another means. Alternations in semi-onomatopoeic words are substantial evidence because they are phonological patterns of a steady-state natural language.

All in all, I consider palatals [tɕ, tɕ^h, ɕ] as allophones of the velar phonemes /k, k^h, x/ in Standard Chinese. The dental proposal is weak in authenticity of data, and the palatal proposal fails to account for the non-contrastive relation between palatals and the complementarily distributing series.

2.3 Phonemic inventory of Xuzhou vowels

This section studies the phonemic inventory of Xuzhou vowels. I will focus on vowels in mono-syllabic words. The subsections are arranged according to the height dimension. Apical vowels and nasal vowels are discussed in separate parts.

2.3.1 High vowels

[i, u, y] are three high vowels in Xuzhou. Their positions in a syllable are flexible. Kenstowicz (1994:278) divides segments into three groups concerning their roles in a syllable: ones that only occur as nuclei, ones that never appear at the nuclear position, and ones that alternate between the nuclear and non-nuclear positions. [i, u, y] in Xuzhou belong to the third group. Su and Lü (1996) use the IPA symbols [i, u, y] for vowels and glides in an indiscriminate manner. In this thesis, glides are transcribed as [j, w, ɥ] for the purpose of distinguishing different roles in a syllable.

High vowels or glides can form minimal pairs. Minimal pairs in a particular language refer to pairs of words which differ in only one phonological element and have distinct meanings.

(8) *Minimal pairs of high vowels and glides* (Su and Lü 1996)

a.	[i^{213}]	一	'one'	b.	[i^{55}]	姨	'aunt'
	[u^{213}]	屋	'house'		[u^{55}]	无	'noun'
	[y^{213}]	狱	'prison'		[y^{55}]	鱼	'fish'
c.	[i^{35}]	椅	'chair'	d.	[i^{51}]	意	'meaning'
	[u^{35}]	五	'five'		[u^{51}]	误	'delay'
	[y^{35}]	雨	'rain'		[y^{51}]	喻	'metaphor'
e.	[jæ̃^{213}]	烟	'smoke'	f.	[jæ̃^{55}]	严	'strict'
	[wæ̃^{213}]	弯	'bend'		[wæ̃^{55}]	完	'finish'
	[ɥæ̃^{213}]	冤	'injustice'		[ɥæ̃^{55}]	圆	'round'
g.	[jæ̃^{35}]	眼	'eye'	h.	[jæ̃^{51}]	宴	'banquet'
	[wæ̃^{35}]	碗	'bow'		[wæ̃^{51}]	万	'ten thousand'
	[ɥæ̃^{35}]	远	'far'		[ɥæ̃^{51}]	怨	'complain'

(8) exemplifies the minimal pairs of high vowels or glides in Xuzhou. The vowels [i], [y] and [u] can appear in the same syllable structures like V, CV, VC or CVC, and the glides [j], [w] and [ɥ] can appear in the GV structure. Minimal pairs are found in words with different tones. (8a.-d.) demonstrate [i, u, y] in syllables of the *falling-rising tone* 213, the *high level tone* 55, the *rising tone* 35 and the *falling tone* 51. Mono-syllabic words in each set of data differ in one and only one segment, i.e. the nuclear vowels. This crucial factor differentiates word meanings. (8e.-h.) give another four sets of words which have the unique difference in glides and convey different meanings. All the evidence show that high vowels/glides are in contrastive distribution. Thus /i, u, y/ are the high vowel phonemes.

2.3.2 Mid vowels

There are six mid vowels in Xuzhou [e, ɛ, ə, ɤ, o, ɔ]. They always occur at the nuclear positions. The vowels [e, ɛ, ə, ɔ] can appear in isolation, forming a syllable on their own. The vowels [ɤ, o] are found in specific contexts, where [ɤ] is always followed by the coda [-ɻ] and [o] is always followed by the coda [-w].

(9) *Minimal pairs of e, ɛ, ə, ɔ* (Su and Lü 1996)

a.	[ke^{213}]	隔	'separate'
	[kɛ^{213}]	该	'should'
	[kə^{213}]	歌	'sound'
	[kɔ^{213}]	高	'talk'
b.	[k^{h}e^{213}]	客	'guest'
	[k^{h}ɛ^{213}]	开	'open'
	[k^{h}ə^{213}]	渴	'thirsty'
	[k^{h}ɔ^{213}]	尻	'have sex'
c.	[xe^{213}]	黑	'black'
	[xɛ^{213}]	□	'great amount'
	[xə^{213}]	喝	'drink'
	[xɔ^{213}]	蒿	'wormwood'

[e, ɛ, ə, ɔ] can form minimal pairs, shown in (9). Minimal pairs of the four vowels are only found in syllables having the velar onsets [k, k^h, x]. The words bear a complex contour tone *213*. Since the four vowels can occur in syllables which only differ in nuclei and the meanings of mono-syllabic words are contrasted, /e, ɛ, ə, ɔ/ are four independent phonemes.

[ɤ] is always found before a coda [-ɻ]. Xuzhou has a diminutive suffix /-ər/ (儿). Occurrence of the coda [-ɻ] results from diminutive suffixation. I will refer to this process as *ɻ*-suffixation in order to emphasize the importance of the rhotic color in the suffix. The term '*ɻ*-suffixation' equals to '*Er*-suffixation' in traditional Chinese phonology.

(10) *ɤ under ɻ-suffixation* (Su and Lü 1996)

[tʂə^{51}] + /ər/	→	[tʂɤɻ^{51}]	这儿	'here'
[tjə^{55}] + /ər/	→	[tjɤɻ^{55}]	碟儿	'small plate'
[pwə^{55}] + /ər/	→	[pwɤɻ^{55}]	脖儿	'neck'
[tɕɥə^{213}] + /ər/	→	[tɕɥɤɻ^{213}]	角儿	'corner'

The base words in (10) have open syllables with the nucleus [ə]. After *ɻ*-suffixation, the suffixed words obtain the coda [-ɻ] and the nucleus becomes [ɤ]. Lin (2007:182) suggests that word formation processes can induce segmental changes. I propose that [ɤ] and [ə] are allophones of the same phoneme /ə/, and consider the change to [ɤ] is due to the morpho-phonemic process.

Occurrence of [o] is narrow. It only precedes a syllable-final [-w]. This is in contrast with other mid vowels [e, ɛ, ə, ɔ] which can never be followed by [-w]. [o] is phonetically more similar to [ə, ɔ] than to [e, ɛ] in terms of vowel backness. It is much closer to [ɔ] than to [ə] regarding vowel roundedness. Thus I propose that [o] is a variant of /ɔ/ by reason of complementary distribution and phonetic similarities[6].

[6] This consideration owes to Prof. Jiang-King Ping's insight.

2.3.3 Low vowels

Xuzhou has two low vowels [ɑ, ɐ]. They can form minimal pairs. (11) illustrates two words which only differ in the nuclei and have different meanings. Since [ɑ] and [ɐ] are contrastive, they can not be variants of the same phoneme.

(11) *Minimal pairs of ɑ, ɐ* (Su and Lü 1996)

[ɕjɑɻ^{55}]	匣儿	'small box'
[ɕjɐɻ^{55}]	鞋儿	'small shoes'

[ɑ] comes from the phoneme of /ɑ/ because its occurrence does not require any conditioning environment. (12a.) provides all syllable structures that [ɑ] can occur. (12b.) illustrates words of a singleton [ɑ] in four tones. The evidence demonstrates that its realization does not depend on the surrounding segments or specific tones.

(12) *Occurrences of ɑ* (Su and Lü 1996)

a.	V	[ɑ^{51}]	啊	onomatopoeia
	CV	[tɑ^{51}]	大	'big'
	VC	[ɑŋ^{213}]	骯	'dirty'
	CVC	[pɑŋ^{213}]	帮	'help'
	GV	[jɑ^{55}]	牙	'teeth'
	CGV	[tɕjɑ^{213}]	家	'family'
	GVC	[jɑŋ^{55}]	羊	'sheep'
	CGVC	[ɕjɑɻ^{55}]	匣儿	'small box'
b.	V	[ɑ^{213}]	腌	'dirty'
		[ɑ^{55}]	阿	a prefix to name
		[ɑ^{35}]	阿	exclamation
		[ɑ^{51}]	啊	onomatopoeia

[ɐ] always co-occurs with a following [-ɻ]. It only appears under *ɻ*-suffixation. The base words in (13) have two different nuclear vowels. One is the oral vowel [ɛ] and the other is the nasal vowel [æ̃]. It is not clear whether [ɐ] is realized from /ɛ/ or /æ̃/ because nasal vowels have not been discussed and the phonemic status of [æ̃] is uncertain for the time being. I will return to this issue after studying nasal vowels.

(13) *ɐ under ɻ-suffixation* (Su and Lü 1996)

[pʰɛ^{55}] + /ɚ/	→	[pʰɐɻ^{55}]	牌儿	'card'
[pʰæ̃^{55}] + /ɚ/	→	[pʰɐɻ^{55}]	盘儿	'dish'
[ɕjɛ^{55}] + /ɚ/	→	[ɕjɐɻ^{55}]	鞋儿	'small shoes'
[ɕjæ̃^{55}] + /ɚ/	→	[ɕjɐɻ^{55}]	弦儿	'thin cord'
[xwɛ^{55}] + /ɚ/	→	[xwɐɻ^{55}]	怀儿	'pregnant'
[xwæ̃^{55}] + /ɚ/	→	[xwɐɻ^{55}]	环儿	'ring'

2.3.4 Apical "vowels"

Three apical vowels [ɿ, ʅ, ɚ] are found in Xuzhou (Su and Lü 1996). Their active articulator is the tip of the tongue, making them significantly different from laminal vowels whose active articulator is the tongue body.

[ɚ] never co-occur with other segments. It forms an entire syllable. The words of the syllable [ɚ] can bear three tones, as shown in (14). Since realization of the vowel [ɚ] is not conditioned by any phonological environment, I propose that the segment /ɚ/ exists underlyingly.

(15) *Occurrences of əɻ* (Su and Lü 1996)

V			
	[ɚ^{55}]	儿	'son'
	[ɚ^{35}]	耳	'ear'
	[ɚ^{51}]	二	'two'

[ɿ, ʅ] are traditionally described as vowels, but I am going to argue that they are syllabic approximants prolonged from onset stridents or approximant. The phonological behaviors of [ɿ, ʅ] in Xuzhou have much likeness with the sounds in Standard Chinese. First, [ɿ, ʅ] only occur in CV syllables. Secondly, [ɿ] only follows dental affricates or fricative [ts, tsʰ, s], and [ʅ] only follows retroflexes [tʂ, tʂʰ, ʂ, ɻ]. Thirdly, [ɿ, ʅ] are complementarily distributed with the high front unrounded vowel [i].

(15) presents the distributions of [i, ɿ, ʅ] in Xuzhou. Syllables which are not found in this language are marked with the asterisk '*'. It is possible for [ɿ, ʅ, i] to be variants of the same phoneme because they are in complementary distribution. If so, /i/ should be the underlying form for two reasons. On the one hand, [i] has the wider distribution. On the other hand, [ɿ, ʅ] can not occur in syllables with zero onset whereas [i] can. Since the active and passive articulators of [ɿ, ʅ] are similar to their preceding consonants, it is logic to consider their realizations result from progressive assimilation.

(15) *Distributions of [i], [ɿ] and [ʅ]*

	i			ɿ			ʅ		
p	[pi^{213}]	逼	'force'	*[pɿ]			*[pʅ]		
p^{h}	[p^{h}i^{213}]	劈	'cleave'	*[p^{h}ɿ]			*[p^{h}ʅ]		
m	[mi^{213}]	蜜	'honey'	*[mɿ]			*[mʅ]		
f	[fi^{213}]	飞	'fly'	*[fɿ]			*[fʅ]		
v	[vi^{213}]	微	'tiny'	*[vɿ]			*[vʅ]		
t	[ti^{213}]	低	'low'	*[tɿ]			*[tʅ]		
t^{h}	[t^{h}i^{213}]	踢	'kick'	*[t^{h}ɿ]			*[t^{h}ʅ]		
l	[li^{213}]	栗	'chestnut'	*[lɿ]			*[lʅ]		
ts	*[tsi]			[tsɿ^{213}]	滋	'nourish'	*[tsʅ]		
ts^{h}	*[ts^{h}i]			[ts^{h}ɿ^{213}]	刺	'satirize'	*[ts^{h}ʅ]		
s	*[si]			[sɿ^{213}]	丝	'silk'	*[sʅ]		
tʂ	*[tʂi]			*[tʂɿ]			[tʂʅ^{213}]	知	'know'
tʂ^{h}	*[tʂ^{h}i]			*[tʂ^{h}ɿ]			[tʂ^{h}ʅ^{213}]	吃	'eat'
ʂ	*[ʂi]			*[ʂɿ]			[ʂʅ^{213}]	湿	'wet'
ɻ	*[ɻi]			*[ɻɿ]			[ɻʅ^{213}]	日	'sun'
tɕ	[tɕi^{213}]	鸡	'chicken'	*[tɕɿ]			*[tɕʅ]		
tɕ^{h}	[tɕ^{h}i^{213}]	七	'seven'	*[tɕ^{h}ɿ]			*[tɕ^{h}ʅ]		
ɕ	[ɕi^{213}]	西	'west'	*[ɕɿ]			*[ɕʅ]		
ȵ	[ȵi^{213}]	妮	'girlie'	*[ȵɿ]			*[ȵʅ]		
∅	[i^{213}]	衣	'clothes'	*[ɿ]			*[ʅ]		

However, the fundamental problem is that [ɿ, ʅ] and [i] are not phonetically similar. [ɿ, ʅ] are produced with the tip of the tongue whereas [i] is produced with the tongue body. Hence [ɿ, ʅ] and [i] shall NOT be allophones of the same phoneme.

If /i/ were the phoneme, motivation for its allophone [ɿ] shall be the dental articulator of onset consonants. But evidence shows that dental onsets do not necessarily cause the change from /i/ to [ɿ]. [t, t^h, n, l] in (16a.) and [ts, ts^h, s] in (16b.) are all dental consonants. [ɿ] only co-occurs with onsets in (16b.) but not with those in (16a.). Thus the proposal for /i/ being the phoneme of [ɿ] can not explain its different phonotactic behaviors with dental onsets.

(16) *Co-occurrences between dental onsets and [ɿ]*

a. *tɿ *t^hɿ *nɿ *lɿ
b. tsɿ ts^hɿ sɿ

The continuant feature of onsets is as important as their place features. Stridents include fricatives and affricates. Among dental consonants, [ts, ts^h, s] are stridents but [t, t^h, n, l] are not. The entire production of fricatives and the second stage of affricates are continuous. Prolongation of stridents can give birth to approximants, and the retroflex [ɻ] is intrinsically an approximant. Since approximants can become syllabic and appear as nuclei (Duanmu 2000:36-37), it is reasonable to assume that [ɿ, ʅ] are syllabic approximants.

Therefore, I consider [ɿ] to be the syllabic dental approximant and [ʅ] to be the syllabic retroflex approximant[7]. Notationally, [ɿ] shall be [ɻ̩] and [ʅ] shall be [ɻ̩]. They do not exist underlyingly. Occurrences of [ɻ̩] and [ɻ̩] are predictable from onset consonants and syllable structures.

[7] I would like to acknowledge Prof. Jiang-King Ping's contribution to this idea. She reminded me of the phonotactic behaviors of different dental onsets.

2.3.5 Nasal vowels

Seven nasal vowels are found in Xuzhou mono-syllabic words. They are [ĩ, ỹ, ũ, ẽ, æ̃, ə̃, ɑ̃]. They can only occur at the syllable-nuclear positions. Five of them [ĩ, ỹ, ũ, ə̃, ɑ̃] must be followed by the coda [-ɻ], while the other two [ẽ, æ̃] never precede any coda.

2.3.5.1 Nasal vowels from *ɻ*-suffixation

Occurrences of [ĩ, ỹ, ũ, ə̃, ɑ̃] are illustrated in (17). Li (1983:45) and Su and Lü (1996:5) report that these nasal vowels are derived from /iŋ, yŋ, uŋ, əŋ, ɑŋ/ under *er-hua* ('*ɻ*-suffixation').

(17) *ĩ, ỹ, ũ, ə̃, ɑ̃ under ɻ-suffixation* (Su and Lü 1996)

[tɕiŋ^{35}] + /ɚ/	→	[tɕĩɻ^{35}]	景儿	'lovely scenery'
[yŋ^{35}] + /ɚ/	→	[ỹɻ^{35}]	蛹儿	'little pupa'
[tʂuŋ^{213}] + /ɚ/	→	[tʂũɻ^{213}]	盅儿	'small cup'
[fəŋ^{51}] + /ɚ/	→	[fə̃ɻ^{51}]	缝儿	'tiny flaw'
[jɑŋ^{213}] + /ɚ/	→	[jɑ̃ɻ^{213}]	秧儿	'seedling'

Base words in (17) have the rimes [iŋ, yŋ, uŋ, əŋ, ɑŋ]. In derived words, the coda [-ɻ] replaces [-ŋ] and the nuclear vowels become nasal. Since [ĩ, ỹ, ũ, ə̃, ɑ̃] result from the morpho-phonemic process, they are actually *nasalized* vowels. Thus their underlying forms shall be oral. They are /i, y, u, ə, ɑ/.

2.3.5.2 Nasal vowels from co-occurrence restriction

[ẽ, æ̃] are only found in open syllables. They do not co-occur with the coda [-ɻ]. Syllables containing them can undergo ɻ-suffixation. The nasal vowels in base words become oral in derived words. They also change from front vowels to central. This is illustrated in (18).

(18) *ẽ, æ̃ under ɻ-suffixation* (Su and Lü 1996)

[$p^hẽ^{55}$] + /ɚ/	→	[$p^həɻ^{55}$]	盆儿	'small basin'
[jẽ^{213}] + /ɚ/	→	[jəɻ^{213}]	音儿	'weak sound'
[læ̃^{55}] + /ɚ/	→	[lɐɻ^{55}]	篮儿	'small basket'
[jæ̃^{35}] + /ɚ/	→	[jɐɻ^{35}]	眼儿	'eye'

[ẽ] has phonetic similarities with both the front vowel [e] and the central vowel [ə]. Its phonotactic behavior is similar to that of the central vowel, but is different from that of the front vowels. [æ̃] is phonetically close to both the front vowel [ɛ] and the central vowel [ɐ]. It behaves like a non-front vowel in phonotactics.

(19) *Phonotactic behaviors of nasal vowels* (Su and Lü 1996)

a.	*ɥe	*ɥɛ		ɥẽ	ɥæ̃	ɥə
b.	*tʂe	*tʂɛ		tʂẽ	tʂæ̃	tʂə
	*tʂʰe	*tʂʰɛ		tʂʰẽ	tʂʰæ̃	tʂʰə
	*ʂe	*ʂɛ		ʂẽ	ʂæ̃	ʂə
	*ɻe	*ɻɛ		ɻẽ	ɻæ̃	ɻə

(19a.) shows that the front glide [ɥ-] can not co-occur with front vowels [e] or [ɛ]. This can be explained by the same backness value between the glide and the vowel. On the contrary, [ɥ-] can co-occur with the nasal vowels. Since adjacent identical features are not allowed, the nasal vowels shall not be front. (19b.) shows that retroflex consonants do not co-occur with front vowels, but they are compatible with the nasal vowels. Thus I propose that [ẽ, æ̃] are realized from central vowels[8].

[8] This consideration owes to Prof. Jiang-King Ping's insight.

(20) *Correspondence between nasal vowel/coda in XZ and nasal coda in MC*

Example	Transcription of word in XZ	Rime category in MC	Reconstructed coda in MC
含 'include' 敢 'dare to' 盐 'salt'	[xæ̃^{55}] [kæ̃^{35}] [jæ̃^{55}]	*Xian* 咸	-m
林 'forest' 心 'heart' 枕 'pillow'	[ljẽ^{55}] [ɕjẽ^{213}] [tʂẽ^{35}]	*Shen* 深	
丹 'red' 善 'goodness' 言 'language'	[tæ̃^{213}] [ʂæ̃^{51}] [jæ̃^{55}]	*Shan* 山	-n
本 'book' 寸 'inch' 云 'cloud'	[pẽ^{35}] [tsʰwẽ^{51}] [ɥẽ^{55}]	*Zhen* 臻	
帮 'help' 墙 'wall' 光 'light'	[pɑŋ^{213}] [tɕʰjɑŋ^{55}] [kwɑŋ^{213}]	*Dang* 宕	-ŋ
双 'pair' 讲 'speak' 项 'item'	[ʂwɑŋ^{213}] [tɕjɑŋ^{35}] [ɕjɑŋ^{51}]	*Jiang* 江	
朋 'friend' 增 'increase' 兴 'flourish'	[pʰəŋ^{55}] [tsəŋ^{213}] [ɕiŋ^{213}]	*Zeng* 曾	
兵 'soldier' 井 'well' 声 'sound'	[piŋ^{213}] [tɕiŋ^{35}] [ʂəŋ^{213}]	*Geng* 梗	
冬 'winter' 从 'follow' 用 'use'	[tuŋ^{213}] [tsʰuŋ^{55}] [yŋ^{51}]	*Tong* 通	

Linguists assume that Modern Chinese dialects evolve from Middle Chinese. (20) makes use of *Fangyan Diaocha Zibiao* 'a dialect investigator's handbook' (CASS 2005:30-80) and lists nine rime categories in Middle Chinese (MC in short). Reconstruction of Middle Chinese assumes that *Xian* and *Shen* rimes had the [-m] coda, *Shan* and *Zhen* rimes had the [-n] coda, and the other five rimes had the [-ŋ]

coda (Wang 1980:181-207). Three examples are selected from the handbook and transcribed into Xuzhou. The results show that [ẽ, æ̃] in Xuzhou were produced with the nasal coda [-m] or [-n] in Middle Chinese. The table indicates that [ẽ, æ̃] can be realized from vowel-nasal combination /V+N/. Yet it does not tell whether nasalization is synchronic or diachronic. I suggest that it is a synchronic process. The analogy is made from (21).

(21) *Comparison between æ̃/ẽ in XZ and -n in SC*

a.

Words in XZ	Glossary	Words in SC
[pæ̃^{213}]	班 'class'	[pan^{55}]
[p^{h}æ̃^{51}]	盼 'expect'	[p^{h}an^{51}]
[mæ̃^{51}]	慢 'slow'	[man^{51}]
[fæ̃^{35}]	反 'reverse'	[fan^{214}]
[twæ̃^{35}]	短 'short'	[twan^{214}]
[t^{h}æ̃^{55}]	谈 'talk'	[t^{h}an^{35}]
[næ̃^{55}]	男 'male'	[nan^{35}]
[læ̃^{55}]	蓝 'blue'	[lan^{35}]
[tsæ̃^{51}]	赞 'praise'	[tsan^{51}]
[ts^{h}æ̃^{213}]	餐 'meal'	[ts^{h}an^{55}]
[sæ̃^{35}]	伞 'umbrella'	[san^{214}]
[tʂæ̃^{35}]	展 'exhibition'	[tʂan^{214}]
[tʂ^{h}æ̃^{55}]	缠 'tangle'	[tʂ^{h}an^{35}]
[ʂæ̃^{213}]	删 'delete'	[ʂan^{55}]
[ɻæ̃^{35}]	染 'dye'	[ɻan^{214}]
[tɕɥæ̃^{35}]	卷 'roll'	[tɕɥɛn^{214}]
[tɕ^{h}jæ̃^{55}]	钱 'money'	[tɕ^{h}jɛn^{35}]
[ɕjæ̃^{213}]	鲜 'fresh'	[ɕjɛn^{55}]
[ȵjæ̃^{55}]	年 'year'	[njɛn^{35}]
[kæ̃^{35}]	敢 'dare'	[kan^{214}]
[k^{h}æ̃^{51}]	看 'look'	[k^{h}an^{51}]
[xæ̃^{55}]	含 'include'	[xan^{35}]
[æ̃^{51}]	暗 'dark'	[an^{51}]

b.

Words in XZ	Glossary	Words in SC
[pɛ̃^{51}]	笨 'stupid'	[pən^{51}]
[p^{h}ɛ̃^{55}]	盆 'basin'	[p^{h}ən^{35}]
[mɛ̃^{55}]	门 'door'	[mən^{35}]
[fɛ̃^{35}]	粉 'powder'	[fən^{214}]
[twɛ̃^{213}]	吨 'ton'	[twən^{55}]
[t^{h}wɛ̃^{213}]	吞 'swallow'	[t^{h}wən^{55}]
[nɛ̃^{35}]	恁 'you'	[nən^{51}]
[ljɛ̃^{55}]	林 'forest'	[lin^{35}]
[tswɛ̃^{213}]	尊 'respect'	[tswən^{55}]
[ts^{h}wɛ̃^{213}]	村 'village'	[ts^{h}wən^{55}]
[sɛ̃^{213}]	森 'forest'	[sən^{55}]
[tʂɛ̃^{213}]	针 'needle'	[tʂən^{55}]
[tʂ^{h}ɛ̃^{55}]	沉 'heavy'	[tʂ^{h}ən^{35}]
[ʂɛ̃^{213}]	身 'body'	[ʂən^{55}]
[ɻɛ̃^{51}]	认 'recognize'	[ɻən^{51}]
[tɕɥɛ̃^{213}]	军 'army'	[tɕɥyn^{55}]
[tɕ^{h}jɛ̃^{213}]	亲 'kiss'	[tɕ^{h}in^{55}]
[ɕjɛ̃^{213}]	心 'heart'	[ɕin^{55}]
[kɛ̃^{213}]	跟 'follow'	[kən^{55}]
[k^{h}ɛ̃^{35}]	肯 'willing'	[k^{h}ən^{214}]
[xɛ̃^{35}]	很 'very'	[xən^{214}]
[ɛ̃^{213}]	恩 'boom'	[ən^{55}]

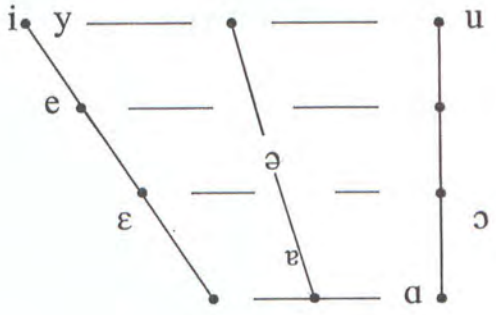
(21) is a comparison between [æ̃, ɛ̃] in Xuzhou and the [-n] coda in Standard Chinese. The first column lists all onset consonants that can precede [æ̃] or [ɛ̃], the three medial glides and the four tones in Xuzhou. The second column provides Chinese characters and English glossary of the words. The third column displays transcriptions of the same words in Standard Chinese. Results show that those words with [æ̃] or [ɛ̃] in Xuzhou are always produced with the dental nasal coda [-n] in Standard Chinese, regardless of onsets, glides or tones.

Since Xuzhou and Standard Chinese evolve from the same ancestor Middle Chinese and they belong to the same dialect group *Mandarin* in Modern Chinese, I assume that /-n/ exist in both languages. The coda /-N/ following central vowels in Xuzhou is the dental nasal /-n/[9]. It can not be realized in speech because of the constraint that prohibits the coda *[–n]. The underlying representation of [ẽ] and [æ̃] are /ə/ and /ɐ/ respectively.

2.3.6 Summary

This section studies Xuzhou vowel phonemes. Vowel phonemes are determined by evidence of minimal pairs. Allophonic relations are identified by phonetic similarities and complementary distributions. Nasal vowels are proposed to be realized from oral vowels through nasalization. (22) presents a chart of laminal vowel phonemes, and the apical vowel /ɚ/ is not included.

(22) *Phonemic vowel inventory*



Minimal pairs of the vowels are exemplified in (23). They can not be found in exactly the same syllable structures. (23a.) shows independence of seven vowels [i, u, e, ɔ, ɛ, ɑ] excluding [ə, ɚ], (23b.) shows independence of eight vowels [i, u, ə, ɔ, ɛ, ɑ, ɚ] excluding [e], (23c.) indicates that [ə] and [e] are allophones of separate phonemes, and (23d.) indicates that [ɐ] and [ɑ] are allophones of different phonemes.

[9] I cannot come to this proposal without Prof. Jiang-King Ping's comment on my original idea.

(23) *Minimal pairs of Xuzhou vowels*

a.

/i/	[li^{55}]	梨	'pear'
/y/	[ly^{55}]	驴	'donkey'
/u/	[lu^{55}]	炉	'stove'
/e/	[le^{55}]	雷	'thunder'
/ɔ/	[lɔ^{55}]	劳	'fatigue'
/ɛ/	[lɛ^{55}]	来	'come'
/ɑ/	[lɑ^{55}]	落	'residue'

b.

/i/	[i^{55}]	姨	'aunt'
/y/	[y^{55}]	鱼	'fish'
/u/	[u^{55}]	无	'nothing'
/ə/	[ə^{55}]	鹅	'goose'
/ɔ/	[ɔ^{55}]	熬	'boil'
/ɛ/	[ɛ^{55}]	呆	'stubborn'
/ɑ/	[ɑ^{55}]	啊	onomatopoeia
/əɻ/	[ɚ^{55}]	儿	'son'

c.

/e/	[k^{h}e^{213}]	客	'guest'
/ə/	[k^{h}ə^{213}]	渴	'thirsty'

d.

/ɐ/	[p^{h}ɐɻ^{55}]	耙儿	'little rake'
/ɑ/	[p^{h}ɑɻ^{55}]	盘儿	'little plate'

2.4 Phonemic inventory of Xuzhou consonants

This section examines the phonemic inventory of consonants. Subsections are organized according to the places of articulation of consonants. Nasals are discussed in a separate part because they have syllabic variants.

2.4.1 Labials

Xuzhou has five labial consonants [p, p^h, m, f, v]. Four of them [p, p^h, f, v] can only appear syllable-initially. [m] is mostly found as an onset, but it can also serve as a nucleus. The nuclear nasals will be discussed in the last subsection.

(24) *Minimal pairs of p, p^h, m, f, v* (Su and Lü 1996)

a.	[pi^{55}]	鼻	'nose'
	[p^hi^{55}]	疲	'tired'
	[mi^{55}]	迷	'myth'
	[fi^{55}]	肥	'fat'
	[vi^{55}]	唯	'only'
b.	[pu^{213}]	不	'no'
	[p^hu^{213}]	扑	'throw oneself on'
	[mu^{213}]	木	'wood'
	[fu^{213}]	福	'good fortune'
c.	[pu^{35}]	补	'repair'
	[p^hu^{35}]	普	'common'
	[mu^{35}]	母	'mother'
	[fu^{35}]	斧	'ax'
d.	[pu^{51}]	布	'cloth'
	[p^hu^{51}]	铺	'small shop'
	[mu^{51}]	墓	'tomb'
	[fu^{51}]	父	'father'

[p, p^h, m, f, v] can form minimal pairs, as shown in (24). [v] only co-occurs with the high front unrounded vowel [i] and the syllables must bear the high level tone *55*. Thus (24a.) is the only type of examples for the five labials. Minimal pairs of [p, p^h, m, f] are more common. Labials are contrastive when they have different

rimes or bear different tones. Examples are shown in (24b.-d.). Thus they are allophones of separate phonemes.

[v] is the only voiced obstruent in Xuzhou[10]. Its occurrence is narrow, only preceding the vowel [i]. Su and Lü (1996:4) describe that most words which used to be pronounced as [vi] become [we] nowadays. [v] is a labial-dental sound and [w] is a labial-velar sound. [v] only co-occurs with [i] but [w] never co-occurs with [i]. I consider that [v] and [w] are allophones of the same phoneme owing to their phonetic similarity and complementary distribution. Since /u/ is the phoneme of [w], it is also the phoneme of [v].

As a result, three consonant phonemes can be proposed /p, p^h, f/, leaving the phoneme of [m] to later discussion.

2.4.2 Dentals

There are seven dental consonants [t, t^h, n, l, ts, ts^h, s]. Six of them [t, t^h, l, ts, ts^h, s] can only occur at the syllable-initial position. Like the labial nasal [m], the dental nasal [n] can be an onset or a nucleus.

[t, t^h, n] are dental stops and [l] is a lateral approximant. They can form minimal pairs. (25) illustrates four groups of examples. Each group bears one tonal type. Since [t, t^h, n, l] can contrast word meanings, they are allophones of separate phonemes. /t, t^h, l/ are proposed, leaving the phoneme of [n] to later discussion.

(25) *Minimal pairs of t, t^h, n, l* (Su and Lü 1996)

a.	[tɑ^{213}]	答	'answer'
	[t^hɑ^{213}]	他	'he'
	[nɑ^{213}]	纳	'include'
	[lɑ^{213}]	辣	'spicy'
b.	[tu^{55}]	读	'read'
	[t^hu^{55}]	图	'map'
	[nu^{55}]	奴	'slave'
	[lu^{55}]	炉	'stove'

[10] My investigation of [v] was driven by Prof. Jiang-King Ping's doubt on the existence of only one voiced obstruent in Xuzhou.

c. [twə^{35}] 躲 'hide'
[t^{h}wə^{35}] 妥 'appropriate'
[nwə^{35}] 诺 'promise'
[lwə^{35}] 掠 'establish relationship with someone'

d. [tɔ^{51}] 到 'arrive'
[t^{h}ɔ^{51}] 套 'set'
[nɔ^{51}] 闹 'cause troubles'
[lɔ^{51}] 涝 'waterlogging'

[ts, ts^{h}, s] are dental strident. Their minimal pairs are exemplified in (26). (26a.-d.) are four groups of mono-syllabic words. Words in each group only differ in onset consonants, which distinguish word meanings. The four groups are different in rhymes and tonal types.

(26) *Minimal pairs of ts, ts^{h}, s* (Su and Lü 1996)

a. [tsu^{213}] 租 'rent'
[ts^{h}u^{213}] 粗 'thick'
[su^{213}] 酥 'crisp'

b. [tsɑ^{55}] 杂 'mixed'
[ts^{h}ɑ^{55}] 茶 'tea'
[sɑ^{55}] □ 'deflate'

c. [tsɔ^{35}] 早 'early'
[ts^{h}ɔ^{35}] 草 'grass'
[sɔ^{35}] 嫂 'sister-in-law'

d. [tsɿ^{51}] 字 'character'
[ts^{h}ɿ^{51}] 刺 'thorn'
[sɿ^{51}] 四 'four'

Dental stridents are phonologically distinct from dental stops and the lateral approximant. (27a.) shows [ts, ts^{h}, s] are contrasted with [t, t^{h}, l], and (27b.) provides an example of [ts, ts^{h}, s] contrasting with [n]. Hence dental stridents and non-stridents have independent phonemes. /ts, ts^{h}, s/ are proposed to be underlying representations of dental stridents.

(27) *Minimal pairs of dental consonants* (Su and Lü 1996)

a.	[tsu^{213}]	租	'rent'
	[ts^{h}u^{213}]	粗	'thick'
	[su^{213}]	酥	'crisp'
	[tu^{213}]	都	'capital'
	[t^{h}u^{213}]	突	'bold'
	[lu^{213}]	鹿	'deer'
b.	[tsɔ^{35}]	早	'early'
	[ts^{h}ɔ^{35}]	草	'grass'
	[sɔ^{35}]	嫂	'sister-in-law'
	[nɔ^{35}]	脑	'brain'

2.4.3 Retroflexes

Xuzhou has four retroflex consonants [tʂ, tʂ^{h}, ʂ, ɻ]. Three stridents [tʂ, tʂ^{h}, ʂ] only appear at the syllable-initial position. The approximant [ɻ] can occur either initially in simple mono-syllable words or finally in complex mono-syllabic words that undergo *-r*-suffixation.

(28) *Minimal pairs of tʂ, tʂ^{h}, ʂ, ɻ* (Su and Lü 1996)

a.	[tʂɿ^{213}]	质	'quality'
	[tʂ^{h}ɿ^{213}]	吃	'eat'
	[ʂɿ^{213}]	湿	'wet'
	[ɻɿ^{213}]	日	'sun'
b.	[tʂɑŋ^{55}]	着	'add flavor'
	[tʂ^{h}ɑŋ^{55}]	常	'often'
	[ʂɑŋ^{55}]	上	'towards a direction or place'
	[ɻɑŋ^{55}]	瓤	'vegetable or fruit flesh'
c.	[tʂu^{35}]	煮	'cook'
	[tʂ^{h}u^{35}]	楚	'a country in ancient China'
	[ʂu^{35}]	叔	'uncle'
	[ɻu^{35}]	汝	'you'
d.	[tʂow^{51}]	皱	'wrinkle'
	[tʂ^{h}ow^{51}]	臭	'smelly'
	[ʂow^{51}]	受	'endure'
	[ɻow^{51}]	肉	'meat'

The retroflexes [tʂ, tʂʰ, ʂ, ɻ] can form minimal pairs, as exemplified in (28). In (28a.-d.), words in each group have different meanings due to the exclusive difference in onset consonants. It indicates that four retroflex consonants are phonologically contrastive. They are allophones of different phonemes /tʂ, tʂʰ, ʂ, ɻ/.

2.4.4 Velars

There are four velar consonants in Xuzhou [k, kʰ, x, ŋ]. The obstruents [k, kʰ, x] can only occur at the syllabic-initial position, where [ŋ] is never found. [ŋ] can occur at the syllable-final position, or become syllabic and form an entire syllable.

Velar obstruents can form minimal pairs. (29) presents four groups of examples. Each group has the only difference in onset consonants which distinguish word meanings. Four groups demonstrate minimal pairs of different tonal types. (29) shows that [k, kʰ, x] are contrastive regardless of tones. Therefore, /k, kʰ, x/ are proposed to be velar phonemes, leaving the phoneme of [ŋ] to later discussion.

(29) *Minimal pairs of k, kʰ, x* (Su and Lü 1996)

a.	[ku^{213}]	姑	'aunt'
	[kʰu^{213}]	哭	'cry'
	[xu^{213}]	呼	'shout'
b.	[kə^{55}]	咯	'quarrel'
	[kʰə^{55}]	□	'unhappy looks'
	[xə^{55}]	河	'river'
c.	[kɔ^{35}]	稿	'draft'
	[kʰɔ^{35}]	考	'exam'
	[xɔ^{35}]	好	'good'
d.	[kæ̃^{51}]	干	'do'
	[kʰæ̃^{51}]	看	'see'
	[xæ̃^{51}]	汗	'sweat'

2.4.5 Palatals

There are four palatal consonants [tɕ, tɕʰ, ɕ, ȵ]. All of them can only occur at the syllable-initial position. While labial and dental nasals [m, n] have syllabic variants, syllabic *[ȵ̩] is never found.

[ȵ] is in complementary distribution with [n]. When *n* is followed by *Xi Yin* ('narrow sound'), the realization is [ȵ] (Su and Lü 1996:4). *Xi Yin* is a term in traditional Chinese phonology. It is contrasted with *Hong Yin* ('broad sound'). They refer to rime types of modern Chinese languages. Rimes beginning with [i]/[j] or [y]/[ɥ] are *Xi Yin*, and rimes beginning with [u]/[w] or non-high vowels are *Hong Yin* (Ding and Li 1981:246). Distributions of [n] and [ȵ] are illustrated in (30).

(30) *Co-occurrences of onset n or ȵ with rimes*

a.

	ɑ	ə	e	ɛ	ɔ	ou	æ̃	ẽ	ɑŋ	əŋ
n	哪		内	乃	脑		奶	恁	囊	弄
ȵ										

b.

	i	jɑ	jə	jɛ	jɔ	jou	jæ̃	jẽ	jɑŋ	iŋ
n										
ȵ	你		聂		鸟	谬	年		娘	拧

c.

	u	wɑ	wə	we	wɛ	wæ̃	wẽ	wɑŋ	uŋ
n	奴		挪			暖			努
ȵ									

d.

	y	ɥə	ɥæ̃	ɥẽ	yŋ
n					
ȵ	女				

e.

	ɚ	ɿ	ʅ
n			
ȵ			

(30a.-d.) list all rimes in Xuzhou that begin with laminal vowels/glides. Rimes in (30a.) do not have pre-nuclear glides. They begin with non-high vowels. [n] can co-occur with them whereas [ȵ] can not. Rimes in (30b.) and (30d.) begin with [i]/[j]

or [y]/[ɥ] respectively. [n̩] co-occurs with them but [n] can not. Rimes in (30c.) begin with [u]/[w]. [n] can co-occur with them, but the onset [n̩] is disfavored. While rimes in (30a.-d.) begin with laminal vowels/glides, (30e.) shows a different rime type. [ɚ, ɻ̩, ɻ] are rimes of apical nuclei. No nasal consonants can co-occur with them. Due to their distributional patterns and arituclatory similarities, [n] and [n̩] are considered as variants of the same phoneme /n/.

The three palatal obstruents [tɕ, tɕ^h, ɕ] can form minimal pairs, shown in (31). Word meanings are contrasted by the differences of these palatal consonants. Thus [tɕ, tɕ^h, ɕ] are phonologically distinct.

(31) *Minimal pairs of tɕ, tɕ^h, ɕ* (Su and Lü 1996)

a.	[tɕi^{213}]	鸡	'chicken'	e.	[tɕjɔ^{213}]	交	'submit'
	[tɕ^{h}i^{213}]	七	'seven'		[tɕ^{h}jɔ^{213}]	敲	'knock'
	[ɕi^{213}]	西	'west'		[ɕjɔ^{213}]	消	'disappear'
b.	[tɕi^{55}]	急	'hurry'	f.	[tɕjɔ^{55}]	嚼	'chew'
	[tɕ^{h}i^{55}]	旗	'flag'		[tɕ^{h}jɔ^{55}]	桥	'bridge'
	[ɕi^{55}]	习	'study'		[ɕjɔ^{55}]	肴	'dishes'
c.	[tɕi^{35}]	几	'how many'	g.	[tɕjɔ^{35}]	饺	'dumpling'
	[tɕ^{h}i^{35}]	起	'up'		[tɕ^{h}jɔ^{35}]	巧	'skillful'
	[ɕi^{35}]	洗	'wash'		[ɕjɔ^{35}]	小	'small'
d.	[tɕi^{51}]	记	'remember'	h.	[tɕjɔ^{51}]	叫	'call'
	[tɕ^{h}i^{51}]	气	'gas'		[tɕ^{h}jɔ^{51}]	俏	'pretty'
	[ɕi^{51}]	细	'thin'		[ɕjɔ^{51}]	笑	'smile'

The data in (31) have two rime types. Four groups (31a.-d.) begin with the high front unrounded vowel [i], and the other four (31e.-h.) begin with the corresponding glide [j]. Palatal consonants can only co-occur with [i]/[j] or [y]/[ɥ]. In contrast, dentals [ts, ts^h, s], retroflexes [tʂ, tʂ^h, ʂ] and velars [k, k^h, x] never co-occur with rimes beginning with [i]/[j] or [y]/[ɥ]. They are in complementary distribution with the palatal series [tɕ, tɕ^h, ɕ]. The following discussion aims to identify the phonemes of [tɕ, tɕ^h, ɕ].

There are four rime categories in traditional Chinese phonology, called *Si Hu* ('four rimes'). *Kai-kou Hu* ('open-mouth pronunciation') refers to syllables whose rimes do not have a pre-nuclear glide and the nuclei are non-high vowels. *Qi-chi Hu* ('level-teeth pronunciation') refers to rimes having an initial *i-* or *j-*. *He-kou Hu* ('closed-mouth pronunciation') refers to rimes having an initial *u-* or *w-*. *Cuo-kou Hu* ('pursed-mouth pronunciation') refers to rimes having an initial *y-* or *ɥ-*.

Co-occurrences between the four consonant types and *Si Hus* are illustrated in (32). Presence of the plus symbol '+' means co-occurrences are allowed, and absence of '+' indicates the opposite. Non-cooccurrences in Xuzhou are grayed out. Two pieces of information can be elicited. First, [tɕ, tɕ^h, ɕ] are allophones with one of the other three consonant types. Evidence is the complementary distribution. Second, realization of [tɕ, tɕ^h, ɕ] is triggered by the following vocoids, because they have the same place of articulation.

(32) *Co-occurrences between four consonant types and Si-Hu*

RIME / ONSET	*Kai-kou Hu* (rime-initial: non-high vowel)	*Qi-chi Hu* (rime-initial: [i]/[j-])	*He-kou Hu* (rime-initial: [u]/[w-])	*Cuo-Kou Hu* (rime-initial: [y]/[ɥ-])
Dentals [ts, ts^h, s]	+		+	
Retroflexes [tʂ, tʂ^h, ʂ]	+		+	
Palatals [tɕ, tɕ^h, ɕ]		+		+
Velars [k, k^h, x]	+		+	

The distributional patterns in (32) are insufficient to determine phonemes of the palatal consonants. It is logically possible for dentals, retroflexes and velars to be assimilated by [i]/[j] or [y]/[ɥ] and become palatalized. I propose that the palatal series [tɕ, tɕ^h, ɕ] and the velar series [k, k^h, x] are allophones of the same phonemes with evidence from palatal-velar alternations.

Xuzhou has a group of semi-onomatopoeic words which describe sounds of successive actions. The words are quadri-syllabic and can be formulated as [Ci^{21}. low^0. CV^T. σ], where *C* stands for consonants, *V* for vowels, the superscript *T* for tones, σ for syllables and the dot '.' for syllable boundaries. It is observed that the first and third syllables usually have the same onset consonants. Nevertheless, when the first syllable begins with a palatal consonant, onset of the third syllable alternates between palatals and velars according to the following vowels or glides. The alternations are exemplified in (33).

(33) *Semi-onomatopoeic words* (Su and Lü 1996)

a.	[p^hi^{21}. low^0. p^hu^{35}. $təŋ^{213}$]	劈娄扑登	[p^h] vs. [p^h]
b.	[ti^{21}. low^0. $tɑ^{35}$. $kuɑ^{51}$]	滴娄打挂	[t] vs. [t]
c.	[$ɕi^{21}$. low^0. $ɕjə^{51}$. $wɛ^{213}$]	稀娄泄歪	[ɕ] vs. [ɕ]
d.	[$ɕi^{21}$. low^0. xu^{35}. $lɑ^{213}$]	稀娄忽剌	[ɕ] vs. [x]
e.	[$tɕi^{21}$. low^0. ku^{35}. tu^{213}]	吉娄咕嘟	[tɕ] vs. [k]
f.	[$tɕi^{21}$. low^0. $kə^{35}$. $tɑ^{213}$]	吉娄疙瘩	[tɕ] vs. [k]

(33a.-c.) are regular quadri-syllabic words, where [p^h] in the first syllable [p^hi^{21}] is identical with [p^h] in the third syllable [p^hu^{35}], [t] in [ti^{21}] with [t] in [$tɑ^{35}$], and [ɕ] in [$ɕi^{213}$] with [ɕ] in [$ɕjə^{51}$]. (33d.-f.) show the [ɕ]~[x] and [tɕ]~[k] alternations. Since the phonetic environment of palatals is restricted to a following [i]/[j] or [y]/[ɥ], other phonetic contexts shall induce allophones of palatals. In (33), the allophones are velars. This group of semi-onomatopoeic words supports velars being variants of palatals.

Palatal-velar alternations are also found in literary-colloquial readings, shown in (34). Words in (34a.) have palatal onsets in the literary readings and velar onsets in the colloquial readings. Words in (34b.) have palatal onsets in the colloquial readings and velar onsets in the literary readings. Appearance of palatals is conditioned by the following high front vowels or glides. The alternations of onset consonants in literary and colloquial pronunciations suggest that palatals have the allophonic relation with velars.

(34) *Alternation of literary and colloquial pronunciations* (Li 1985)

	Literary		*Colloquial*		
a.	[tɕjɑŋ^{35}]	~	[kɑŋ^{35}]	讲	'speak'
	[tɕjɑŋ^{213}]	~	[kɑŋ^{213}]	缰	'halter'
	[ɕjow^{213}]	~	[xou^{213}]	休	'rest'
b.	[kəŋ^{213}]	~	[tɕiŋ^{213}]	更	'night bell'
	[xæ̃^{35}]	~	[ɕiæ̃^{35}]	喊	'cry'

Given that palatals and velars are in complementary distribution and they alternate with each other in the phonological patterns, I identify palatals [tɕ, tɕ^{h}, ɕ] with the velar series [k, k^{h}, x]. Their phonemes are /k, k^{h}, x/ because velars have wider distribution than palatals.

2.4.6 Nasals

Xuzhou has four nasal consonants [m, n, ɳ, ŋ]. [m, n, ɳ] usually occur as onsets and [ŋ] as coda. [m, n, ŋ] can become syllabic and form an entire syllable [m̩], [n̩] or [ŋ̍]. As introduced in section *2.4.5*, [ɳ] and [n] have an allophonic relation. They are found in complementary distribution. [ɳ] only occurs before high front vowels/glides, and [n] occurs elsewhere.

(35) *Minimal pair of m, n* (Su and Lü 1996)

a.	[mɑ^{213}]	妈	'mother'
	[nɑ^{213}]	纳	'incorporate'
b.	[mu^{55}]	谋	'strategy'
	[nu^{55}]	奴	'slave'
c.	[mæ̃^{35}]	满	'full'
	[næ̃^{35}]	南	''south
d.	[mɛ^{51}]	卖	'sell'
	[nɛ^{51}]	耐	'endure'

[m] and [n] are contrastive and their minimal pairs are shown in (35). Since they can occur at the same position in a word and distinguish meanings, [m] and [n] are phonologically distinct, and /m, n/ are proposed as two underlying nasal consonants.

[ŋ] does not occur at the onset position as [m, n, ɳ] do. It is apparently in complementary distribution with the other three nasals. Since it is a velar consonant, [ŋ] is phonetically distant from [m, n, ɳ]. Thus it is realized from a phoneme independent of /m, n/. /ŋ/ is proposed as its underlying form.

There are syllabic [m̩, n̩, ŋ̍] in Xuzhou. A syllabic nasal constitutes an entire syllable. The corresponding mono-syllabic word conveys extra-linguistic information. Word meanings are different due to tonal types. Examples are shown in (36).

(36) *Syllabic nasals*

	Words	*Usage*	*Exemplary implication*
a.	[m̩^{55}]/ [n̩^{55}]/ [ŋ̍^{55}]:	Confirmation	'(You are going, right?) Yes.'
b.	[m̩^{35}]/ [n̩^{35}]/ [ŋ̍^{35}]:	Interrogation	'What did you say?'
c.	[m̩^{51}]/ [n̩^{51}]/ [ŋ̍^{51}]:	Affirmation	'(Did he go out with you?) Yes.'

A high-level tone *55* makes confirmation as in (36a.), a rising tone *35* raises questions as in (36b.), and a falling tone *51* expresses affirmation as in (36c.). As long as the syllables bear the same tones, the word meanings are identical. This interchangeable relation is termed as *free variation*, in which one sound can be substituted for the other without changing the meaning (Roach 1991:38). It occurs between allophones or phonemes. Phonology uses optional rules to explain occurrences of variants in free variation (Odden 2005:60-61). Thus the distribution of free variation does not conflict with the proposal for three nasal phonemes /m, n, ŋ/.

2.4.7 Summary

This section studies the phonemic inventory of Xuzhou consonants. Allophonic relations are identified with evidence from complementary distribution, phonetic similarities, and alternating phonological patterns. Nineteen phonemes /p, p^h, m, f, t, t^h, l, n, ts, ts^h, s, tʂ, tʂ^h, ʂ, ɻ, k, k^h, x, ŋ/ are proposed. They are displayed in (37) with reference to articulatory places and manners.

(37) *Phonemic consonant inventory*

manner \ place		labial	dental	retroflex	palatal	velar
plosive	unaspirated	p	t			k
	aspirated	p^h	t^h			k^h
affricate	unaspirated		ts	tʂ		
	aspirated		ts^h	tʂ^h		
fricative	voiceless	f	s	ʂ		x
	voiced					
nasal		m	n			ŋ
approximant			l	ɻ		

Minimal pairs of contrastive consonants are presented in (38). The velar nasal phoneme /ŋ/ can only occur syllable-finally. It is proposed on the basis of articulatory differences from other nasals, and the segment is not included in the table.

(38) *Minimal pairs of Xuzhou consonants* (Su and Lü 1996)

a.

/p/	[pi^{55}]	鼻	'nose'
/p^{h}/	[p^{h}i^{55}]	疲	'tired'
/m/	[mi^{55}]	迷	'mystery'
/f/	[fi^{55}]	肥	'fat'

b.

/t/	[tɔ^{35}]	岛	'island'
/t^{h}/	[t^{h}ɔ^{35}]	讨	'beg'
/n/	[nɔ^{35}]	脑	'brain'
/l/	[lɔ^{35}]	老	'old'

c.

/ts/	[tsu^{213}]	租	'rent'
/ts^{h}	[ts^{h}u^{213}]	粗	'thick'
/s/	[su^{213}]	酥	'crisp'

d.

/tʂ/	[tʂu^{213}]	猪	'pig'
/tʂ^{h}/	[tʂ^{h}u^{213}]	出	'exit'
/ʂ/	[ʂu^{213}]	书	'book'
/ɻ/	[ɻu^{213}]	入	'enter'

e.

/k/	[ku^{213}]	估	'estimate'
/k^{h}/	[k^{h}u^{213}]	哭	'cry'
/x/	[xu^{213}]	呼	'shout'

f.

/m/	[mɑ^{35}]	马	'horse'
/n/	[nɑ^{35}]	哪	'where'

Chapter 3 Phonotactics

This chapter studies phonotactics of Xuzhou. It examines combinations of Xuzhou consonants and vowels, observes legitimate patternings of sound sequences within a syllable, and draws generalizations on co-occurrence restrictions. I will discuss places and manners of articulation of segments, their syllable positions, and the number of constituents involved in non-cooccurrences.

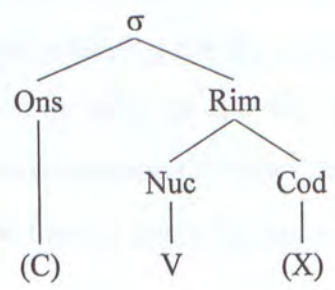
3.1 Syllables in Xuzhou

This section aims to propose the syllable structure of Xuzhou. This work is necessary in two aspects. First, it directly influences the discussion of medial glides (*G*). Whether G is part of Rime or Onset is a question to consider. Second, the syllable structure is concerned with domains of co-occurrence restrictions. This importance will become clear when harmony and disharmony of the same feature are found in different syllable positions.

3.1.1 Previous studies on prenuclear glides in Standard Chinese

The structure of a Chinese syllable is not linear (Chao 1968; Bao 2002; Duanmu 2000; among others). A syllable (σ) is built up by Onset (*Ons*) and Rime (*Rim*), and Rime is constituted by Nucleus (*Nuc*) and Coda (*Cod*). The hierarchy is schematically drawn in (1)[11].

(1)



[11] For simplicity, (1) displays the structure of a 'minor syllable' rather than a 'full syllable'. A full syllable includes a minor syllable and non-linear constituents such as register, tone, length, etc. This clarification owes to Prof. Zhu Xiaonong's suggestion.

However, previous studies which address Chinese syllable structures disagree on the status of the pre-nuclear glide, or Medial (*Med*). In the following, I am going to review the literature on this issue. Since Xuzhou belongs to the same dialectal group with Standard Chinese, I will focus on the medial glides in Standard Chinese. Literatures on other Chinese dialects are discussed whenever necessary.

Chao (1968), following traditional Chinese phonology, treats the medial glides as part of Rime. Chao (1968:18-19) divides a syllable into an initial and a final. The initial is "the way a syllable begins". It can be a consonant or zero. The final of a syllable is "the syllable minus initial". The maximal final consists of three parts: a medial, a main vowel and an ending. Chao's *initial* and *final* in English are translated as *onset* and *rime* respectively in Chinese[12] (Chao 2002:11). Other works in Chinese refer to the combination of the prenuclear glide, the nuclear vowel and the postnuclear glide or consonant as *Yunmu* ('rime').

Duanmu (2000:84-86, 2007:25-30, 2009:76-77) separates glides from Rime, and proposes that it is a secondary articulation of the onset consonants. Rime only includes Nucleus and Coda because the common rhyming part is VX (V stands for Vowel and X for Glide or Consonant), see (2). Four arguments are posited within a syllable (Duanmu 2009:77-78). First, an observation in Chao (1934, in Joos 1957:42) shows that [sw] in English is different from that in Chinese. In English, [sw] sounds like two separate segments while in Chinese it sounds like one. Second, every CG (C stands for Consonant and G for Glide) in Chinese can be represented as one complex sound, see (3). Third, the CVX and CGVX syllables are more or less similar in duration, indicating that the presence of G does not increase the length of a syllable. Hence it is better to use the same syllable structure for both. Fourth, speakers sometimes alternate CG with C, see (4). Therefore, Duanmu thinks G is part of Onset and CG forms a single segment C^G.

[12] Chao (2002) is a Chinese translation of Chao (1968) by Ding Bangxin. The terms *Initial* and *Final* are transcribed as 声母 ('onset') and 韵母 ('rime') respectively. Chao read part of it and wrote a preface for Ding's work, giving credits for its fidelity to the English original.

(2) *Words that rhyme in Standard Chinese* (Duanmu 2009:77(11))

[mæ̃n] 'slow'
[mjæ̃n] 'noodles'
[jæ̃n] 'bright colored'
[tæ̃n] 'egg'
[tjæ̃n] 'shop'
[wæ̃n] 'ten thousand'
[twæ̃n] 'broken'

(3) *Sounds and feature structures* (Duanmu 2009:28(24–25))

[t]: Coronal—[+stop]
[s]: Coronal—[+fricative]
[t^s]: Coronal—[+stop, +fricative]
[p^x]: Labial—[+stop], Dorsal—[+fricative]

(4) *Alternation between palatalized dentals and palatals* (Duanmu 2009:77)

'bird' a. [n^jau]:
b. [ɲau]:
'small' a. [s^jau]:
b. [ɕau]:

Bao (2002:7-24) studies the medial glides in Middle Chinese and in Modern Chinese dialects. He suggests that the status of G in a Chinese dialect is not unified because the distributions of the glides [j] and [w] are asymmetrical. Bao uses two sets of data. One is the *fanqie* ('reverse cut') entries in *Qieyun* ('cutting rimes'), on the basis of which the phonology of Middle Chinese is studied. The other is *L*-words in *Taiyuan* and *Datong* dialects spoken in Shanxi province of China. Examples are shown in (5) and (6) respectively.

(5) *Examples of fanqie spelling* (Bao 2002:14(15), 16(21–22))

σ_1		σ_2		σ_3
ts'ɑt	=	ts'ĭĕt	+	ɣɑt
sɑŋ	=	sĭək	+	lɑŋ
dzĭɛn	=	dzɒi	+	sĭɛn
m'ĭəu	=	mɑk	+	vĭəu
tsuɑn	=	tsĭa	+	kuɑn
ɣuɑi	=	ɣuɑŋ	+	tɑi

(6) *Examples of l-word formation in Taiyuan dialect* (Bao 2002:20 (30))

σ_2	σ_3		σ_1	
pəʔ	lai	(<	pai)	'to wag'
təʔ	ləŋ	(<	təŋ)	'scaffold'
təʔ	liou	(<	tiou)	'to carry'
kəʔ	liau	(<	kiau)	'crooked'
k'uəʔ	lai	(<	k'uai)	'biscuit'
ts'uəʔ	luæ	(<	ts'uæ)	'a string of'

In both sets, there is an original syllable σ_1 and two target syllables σ_2 and σ_3. σ_1 shares the same onset with σ_2, and shares the same rime with σ_3. When σ_1 has G, whether G goes to σ_2 or σ_3 judges its status in σ_1. The findings are σ_1 with an [j]-glide shares it with σ_3, but σ_1 with an [w]-glide shares it with σ_2 or σ_3 randomly. That is to say, [j] is part of Rime whereas [w] is undetermined. Bao follows the assumption that modern Chinese dialects evolve from Middle Chinese and believes that his findings can apply to other *Mandarin* dialects (Bao 2002:24).

To sum up, there have been three major proposals for the status of medial glides in Standard Chinese. The traditional Chinese phonology considers G as part of Rime, Duanmu (2000, 2007, 2009) treats G as part of Onset and views it as a secondary articulation of the onset consonants, and Bao (2002) suggests that different Gs do not have a unified status in a syllable. (7) makes a brief summary.

(7) *Proposals for the status of medial glides in Standard Chinese*

a.	Part of final/rime (Chao 1968; traditional Chinese phonology)
	▫ *Final* is defined as "the syllable minus initial".
b.	Part of initial/onset (Duanmu 2009)
	▫ The rhyming part does not include medial glides ▫ [sw] in Chinese sounds like one sound. ▫ Every CG in Chinese can be represented as one complex sound. ▫ The CVX and CGVX syllables are more or less similar in duration. ▫ Speakers sometimes alternate CG with C.
c.	Not unified (Bao 2002)
	▫ Evidence from Middle Chinese and modern *Mandarin* dialects show that [j] is part of Rime, but the affiliation of [w] can not be determined.

I will discuss G as part of final/rime first. Chao (1968) groups the medial glides into finals by giving a definition in (7a.). Traditional studies in Chinese refer to G as part of *Yunmu* ('rimes') without providing an argument for it. Wang and Chang (2001) give support to this convention by administering two experiments to test native speaker's intuition. They are *fanchie* and *anti-fanchie* experiments. Stimuli are exemplified in (8) and (9) respectively.

(8) *Stimuli for fanchie experiment* (Wang and Chang 2001:248(3))

σ_1	σ_2		σ_3
taj	xan	→	tan
ɕiŋ	tʂən	→	ɕin
tsaw	tuŋ	→	tsuŋ
faŋ	t^hiŋ	→	fəŋ
ts^huŋ	paw	→	ts^haw

(9) *Stimuli for anti-fanchie experiment* (Wang and Chang 2001:253(7))

σ_1		σ_2	σ_3
tan	→	taj	xan
ɕin	→	ɕiŋ	tʂən
tsuŋ	→	tsaw	tuŋ

The first is *fanchie* experiment. 25 college students are asked to fuse two syllables into one by choosing Onset from the input σ_1 and Rime from the input σ_2. Each test pair has two syllables which never have the same G. The result shows that subjects prefer to maintain G from the input σ_2 in the output, and G in the input σ_1 is disfavored in the output regardless of the glide types. The second is *anti-fanchie* experiment. 70 college students are asked to choose from two alternatives to break up a syllable. Each test item has five syllables. An input σ_1 and two output pairs σ_2+σ_3 are given. In one pair, G and Rime of the input σ_1 move together, becoming Rime of the output σ_3. In the other pair, G and Onset of σ_1 move together, becoming Onset of the output σ_2. The result is that subjects tend to choose the pair in which G moves with Rime of the input σ_1. Wang and Chang (2001:256) conclude that the medial glides are "more reasonably grouped with the Rime" in Mandarin syllables.

Next, I will look into Duanmu's arguments. Since G does not belong to the rhyming part, it is taken as part of Onset (Duanmu 2009:76). This reasoning runs hasty because there are two other possibilities. First, G can be independent of both Onset and Rime, dominated directly by the syllable σ. Second, G can be part of Rime, parallel to the rhyming part. The second case empirically exists in Taiwanese (Chung 1997:293). In Taiwanese, G does not rhyme but affects the rhyming pattern. For instance, [an] can rhyme with [jan] or [wan], but [jan] and [wan] never rhyme with each other. If G was part of Onset, [jan] and [wan] would be indifferent to rhyming. But this is not true.

Duanmu (2009:77) uses the [sw] example in Chao (1934) to support the C^G proposal. This shall not be evidential if we trace back to the original work. Chao (1934) makes a comparison between [sw] of [swei] in the English word 'sway' and in the Chinese word *Sui* (岁, 'age'). He points out that [s] and [w] in 'sway' are two independent sounds because [s] is not labialized for most of its duration, whereas [s] and [w] in *Sui* should be considered as one single sound because [s] is completely labialized and the nuclear vowel begins immediately after the [s]-production. However, Chao (1934:42) also says that "But in similar syllables in other tones or with other initial consonants, there is more independence in the [u]-element". Chao's idea is that CG in Chinese speech has difference performances, influenced by tones and consonantal types. He does not claim CG in general forms a single sound.

Another argument is that since every CG in Chinese can be represented as one complex sound, it shall be C^G. Representing CG as one sound is one of proposals in Duanmu (2009:25). He thinks of a complex sound as the merger of two sounds, where merger is viewed as gestural overlap. The crucial requirement is that "all features in a complex sound are simultaneous, in the sense that no sequential timing difference can be used distinctively" (Duanmu 2009:26). In other words, if C and G are not produced at the same time, they shall not be a complex sound. Chao's [sw] discussion above shows that C and G can be produced sequentially.

Duanmu also considers, since the CVX and CGVX syllables are more or less similar in duration indicating that G does not increase the syllable length, it is better

to use the same syllable structure C^G for them. However, this argument is not fully developed. On the one hand, it is not clear to what extent the duration is similar. On the other hand, the short duration of G shall not be a reason to treat it as a secondary articulation because G is transient in nature. Other term for G is 'semi-vowel'. Regarding the status of G in a syllable, the phonological behavior shall be more decisive than the physical duration.

Mai (1999) designs a small experiment when studying G in Cantonese. Both Guangzhou Cantonese speakers and Beijing Mandarin speakers read the word *Gua* (瓜, 'melon') as [kwa]. They are asked to slow down as much as possible. The result shows that Cantonese speakers lengthen [a], whereas the Mandarin speakers lengthen [w] and [a]. G is closely bound to Onset for Cantonese speakers, but it is independent of Onset for Mandarin speakers. He concludes that the two groups of speakers probably have different feelings toward G in their languages (Mai 1999:66). This evidence appeals to native speaker's intuition and supports G as independent of Onset in Mandarin.

Furthermore, Duanmu mentions that sometimes CG alternates with C and provides two examples. One is [nj]~[ɲ] alternation in [njau]/[ɲau] (鸟 'bird'), and the other is [sj]~[ɕ] alternation in [sjau]/[ɕau] (小 'small'). According to my knowledge, [njau] can alternate with [ɲjau] but not [ɲau]. [sjau] is a non-native pronunciation. It is usually heard among Cantonese native speakers who begin to learn Mandarin. [ɕ] can not co-occur with [au], and there shall be a [j] sound between them.

Finally, I turn to Bao (2002) which proposes [j] is part of the Rime but [w] is indeterminate. The proposal is statistically-based. 321 *fanchie* entries separate [j] from Onset, and 46 entries group it with Rime. Only 15 entries group it with Onset. 367 versus 15 indicates a noticeable preference for [j] as part of Rime. But the number of syllables containing [w] is small. Bao (2002:18) confesses that whether [w] are patterned with Onset or Rime in the *fanchie* data "do not shed light on the precise constituency".

Given the above discussion, I will follow the traditional Chinese phonology and treat the medial glides as part of Rime in Standard Chinese. This treatment is supported by native speaker's intuition in Wang and Chang (2001) and Mai (1999). It agrees with Bao's analysis of [j] and does not offend his reports on [w]. On the contrary, Duanmu's view of G being a secondary articulation of Onset is not well justified, and will not be adopted.

3.1.2 Prenuclear glides in Xuzhou syllable structure

A Xuzhou syllable has maximally four segments, including Onset, Medial, Nucleus and Coda. The nucleus is mandatory while the other three constituents are optional. The onset position is usually occupied by consonants, represented by *C*. Glides are hosts of the medial position, represented by *G*. Vowels only occur in the nuclear position, represented by *V*. Both glides and nasal consonants can occur at the coda position, and the segments are represented by *X*. Thus the constituency of a Xuzhou syllable can be linearly expressed as *(C)(G)V(X)*, with braces denoting 'optional'.

Previous studies of Xuzhou syllables group G into Rime (Li 1985; Su and Lü 1996; among others). Although this treatment is not justified, it is consistent with the riming dictionary of Middle Chinese which displays G as part of Rime. In terms of rhyming, medial glides do not belong to the rhyming part. However, I have not found a pair of rhyming syllables with different Gs. It implies that glides might have influence on 'not to rhyme'.

Two nursery rhymes are exemplified in (10). The rhyming syllables are [$ts^h\varepsilon^{55}$] and [$tʂ^hw\varepsilon^{55}$] in (10a.), [$tɕ^hjɔ^{55}$] and [$t^hɔ^{55}$], [$sæ̃^{213}$] and [$tjæ̃^{213}$] in (10b.). (10) shows that rhyming starts from the nuclear vowels, and the rhyming syllables have maximally one type of glides.

(10) *Xuzhou nursery rhymes* (Li 1985:349, 351)

a.

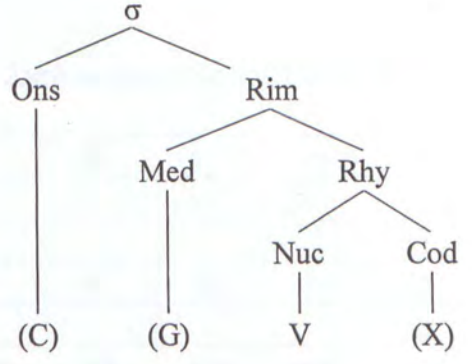
$tʂ^hə^{35}$	$tɑ^{51}$	$tɕy^{51}$		$lɑ^{213}$	$tɑ^{51}$	$tʂ^hɛ^{55}$	1
扯	大	锯，		拉	大	材，	
$tɕi^{51}$	$mjæ̃^{51}$	$wə^{213}$	$wə^{0}$	$yŋ^{51}$	$tsɔ^{35}$	$tʂ^hwɛ^{55}$	2
稭	面	窝	窝	用	枣	撅，	

b.

$tʂ^hwe^{55}$	$tɕjẽ^{213}$	ku^{35}		$kwɑ^{51}$	$tɕjẽ^{213}$	$tɕ^hjɔ^{55}$	1
捶	筋	鼓，		挂	金	桥，	
$wɑŋ^{55}$	mu^{35}	$ȵjɑŋ^{55}$	$ȵjɑŋ^{55}$	tse^{213}	$sæ̃^{213}$	$t^hɔ^{55}$	2
王	母	娘	娘	摘	山	桃。	
tse^{213}	i^{213}	$sæ̃^{213}$		jow^{51}	i^{213}	$sæ̃^{213}$	3
摘	一	山，		又	一	山，	
$wɑŋ^{55}$	mu^{35}	$ȵjɑŋ^{55}$	$ȵjɑŋ^{55}$	$ʂɑŋ^{51}$	$ɕi^{213}$	$tjæ̃^{213}$	4
王	母	娘	娘	上	西	天。	

Without evidence showing that glides belong to the onset part, I will take a conservative position and include it within the rime. I treat G as parallel to the rhyming part VX. The structure of Xuzhou syllables is proposed in (11). *Rhy* refers to the rhyming part and shall be distinguished from the rime *Rim* at the dominant node.

(11)



3.1.3 Onsets and rimes

Xuzhou has twenty-three onset consonants, shown in (12). The onsets are displayed in terms of their places of articulation. Since the dental stridents [ts, ts^h, s] exhibit different phonotactic behaviors from dental non-stridents [t, t^h, n, l], they are separated into two columns.

(12) *Xuzhou onsets* (Su and Lü 1996)

Labials	Dentals		Retroflexes	Palatals	Velars
p	t	ts	tʂ	tɕ	k
p^h	t^h	ts^h	$tʂ^h$	$tɕ^h$	k^h
f		s	ʂ	ɕ	x
v					
m	n			ȵ	
	l		ɻ		

There are thirty-seven rimes in non-suffixed mono-syllabic words, shown in (13). They can be divided into five groups: (a.) rimes without medials, (b.) rimes with [j]-medial, (c.) rimes with [w]-medial, (d.) rimes with [ɥ]-medial, and (e.) rimes with apical nuclei. Since the apical vowel [ɚ] never co-occurs with any other sound, it is irrelevant to the following discussion.

(13) *Xuzhou rimes* (Su and Lü 1996)

a.	i	iŋ	y	yŋ	u	uŋ				
	e	ẽ	ɛ	æ̃	ə	əŋ	ɑ	ɑŋ	ow	ɔ
b.	jẽ	jɛ	jæ̃	jə	jɑ	jɑŋ	jow	jɔ		
c.	we	wẽ	wɛ	wæ̃	wə	wɑ	wɑŋ			
d.	ɥẽ	ɥæ̃	ɥə							
e.	ɿ	ʅ	ɚ							

3.2 Co-occurrences within rimes

This section studies co-occurrences within rimes. I will focus on the co-occurrence restrictions where certain sounds can NOT be combined together. Non-cooccurrences of sounds are stated in terms of their places/manners of articulation and their positions in a syllable. Generalizations are drawn from non-cooccurrences at the end of this section.

3.2.1 Co-occurrences within rimes without medials

A rime without medials consists of an obligatory nucleus and an optional coda. Both vowels and syllabic approximants can take the nuclear position. The nuclear vowels in Xuzhou are provided in (14) in terms of height, backness and roundedness. Since the syllabic approximants [ɻ̩, ʅ] do not co-occur with any sound in the rime, they are beyond the current discussion.

(14) *Xuzhou nuclear vowels* (Su and Lü 1996)

	front		Central	Back	
	unrounded	rounded	unrounded	unrounded	rounded
high	i	y	ə		u
mid	e, ẽ ɛ				o ɔ
low	æ̃			ɑ	

Only two sounds can occur at the coda position. They are the high back rounded glide [-w] and the velar nasal [-ŋ]. (15) lists the combinations of nuclei with the [-w] coda. The asterisk symbol '*' indicates 'not found in this language'.

(15) *Combinations of nuclei and [w]-coda*

a. *iw *yw *uw
b. *ew *ẽw *ɛw *æ̃w *əw *ɑw
c. ow *ɔw

The nuclei in (15a.) are high vowels, and the nuclei in (15b.) are non-high unrounded vowels. Both of them can not precede [-ɯ]. In (15c.), [ow] is allowed but *[ɔw] is not found in this language. In the previous chapter, I argued that [o] and [ɔ] are allophones of /ɔ/ because of their complementary distribution and phonetic similarities. The realization of [o] undergoes regressive assimilation. Since *[ɑw] and *[ɔw] are not found, it can be inferred that the rhyme part of a Xuzhou syllable does not allow co-occurrence of low and high vocoids. Non-coocurrences can be stated as follows.

(16) *High vocoids do not co-occur.*

(17) *Unrounded nuclei do not co-occur with the rounded coda.*

(18) *Low vocoids do not co-occur with high vocoids in rhymes.*

The combinations of nuclei and the [-ŋ] coda are listed in (19). The nuclei in (19a.) are high vowels, and those in (19b.) are non-front unrounded vowels. Rimes in (19a.) and (19b.) are legitimate, showing that high vowels or non-front unrounded vowels can co-occur with the velar nasal coda. However, the nuclear vowels in (19c.) and (19d.) can not appear with [-ŋ]. Vowels in (19c.) are non-high front, and those in (19d.) are non-high rounded. Thus the non-cooccurrences can be stated in (20–21).

(19) *Combinations of nuclei and [ŋ]-coda*

a.	iŋ	yŋ	uŋ	
b.	əŋ	ɑŋ		
c.	*eŋ	*ẽŋ	*ɛŋ	*æ̃ŋ
d.	*oŋ	*ɔŋ		

(20) *Non-high front nuclei do not co-occur with the high back coda.*

(21) *Rounded nuclei do not co-occur with unrounded coda.*

3.2.2 Co-occurrences within rimes with *j*-medial

Rime includes Medial and Rhyme. Rhyme refers to the rhyming part of a syllable, consisting of Nucleus and Coda. Xuzhou has the rhymes shown in (22). For the purpose of expository convenience, they are displayed according to places of articulation of nuclear vowels.

(22) *Rhyming parts in Xuzhou*

	front		Central	Back	
	unrounded	rounded	unrounded	unrounded	rounded
high	i, iŋ	y, yŋ			u, uŋ
mid	e, ẽ ɛ		ə, əŋ		ow ɔ
low	æ̃			ɑ, ɑŋ	

[j] is the high front unrounded glide. (23) shows the combinations of the pre-nuclear [j-] and the rhyming parts.

(23) *Combinations of [j-] and rhyming parts*

a.	*ji	*jiŋ	*jy	*jyŋ	*ju	*juŋ				
b.	*je	jẽ	jɛ	jæ̃	jə	*jəŋ	jɑ	jɑŋ	jow	jɔ

The nuclei in (23a.) are high vowels. None of them can appear with the medial glide. Since both are high vocoids, their non-cooccurrences can be described by the statement in (16), repeated below. The nuclei in (23b.) are non-high vowels. All can co-occur with the medial except for [e] in *[je] and [əŋ] in *[jəŋ]. Since [ɛ] and [e] are both front unrounded vowels and [ɛ] can follow [j-], there is no reason to prevent [e] from the glide. Thus the absence of [je] is considered as an accidental gap.

(16) *High vocoids do not co-occur.* (repeated)

[13] Syllables [i] [u] [y] are not transcribed as [ji] [wu] [ɥy] even though homorganic glides can be occasionally heard in speech. Since high vowels are produced with narrow opening of the oral cavity, it is easy to bring audible friction. I consider such glides are phonetic manifestions which do not have phonological status.

The legitimate rime [jə] shows that [j-] and [ə] are compatible. The well-formed rime [jɑŋ] indicates that the medial [j-] and the coda [-ŋ] can appear in the same syllable. Besides, [əŋ] is an acceptable rhyme in Xuzhou. Since there is no phonetic motivation to reject the rime *[jəŋ], it shall be conceivably accepted. Thus its absence is viewed as an accidental gap.

3.2.3 Co-occurrences within rimes with *w*-medial

[w] is the high back rounded glide. Combinations of the pre-nuclear [w-] and the rhyming parts are shown in (24).

(24) *Combinations of [w-] and rhyming parts*

a.	*wi	*wiŋ	*wy	*wyŋ	*wu	*wuŋ		
b.	*wow	*wɔ						
c.	we	wẽ	wɛ	wæ̃	wə	*wəŋ	wɑ	wɑŋ

The nuclei in (24a.) are high vowels, and the nuclei in (24b.) are rounded vowels. None of them are allowed to follow the high back rounded glide. Rimes in (24c.) are permissible except for *[wəŋ]. Since [w-] can immediately precede the mid central vowel [ə] (e.g. [wə]) and it is compatible with a velar nasal coda [-ŋ] (e.g. [wɑŋ]), there is no reason to reject the rime [wəŋ]. Therefore, its absence is taken as an accidental gap. Non-cooccurrences of (24a.) can be described by (16), and Non-cooccurrences of (24b.) is stated in (25)

(16) *High vocoids do not co-occur.* (repeated)

(25) *The rounded medial does not co-occur with rounded nuclei.*

3.2.4 Co-occurrences within rimes with *ɥ*-medial

[ɥ] is the high front rounded glide. Combinations of the pre-nuclear [ɥ-] and the rhyming parts are displayed in (26).

(26) *Combinations of [ɥ-] and rhyming parts*

a.	*ɥi	*ɥiŋ	*ɥy	*ɥyŋ	*ɥu	*ɥuŋ
b.	*ɥow	*ɥɔ				
c.	*ɥɑ	*ɥɑŋ				
d.	*ɥe	*ɥɛ				
e.	ɥẽ	ɥæ̃	ɥə	*ɥəŋ		

The nuclei in (26a.) are high vowels, the nuclei in (26b.) are rounded vowels, the nucleus in (26c.) is the low back unrounded vowel [ɑ], and the nuclei in (26d.) are front oral vowels. None of them can follow [ɥ-]. Non-cooccurrences of (26a.) can be described by (16). Non-cooccurrences of (26b.) can be described by (25). Non-cooccurrences of (26c.–d.) are stated in (27–28).

(16) *High vocoids do not co-occur.* (repeated)

(25) *The rounded medial does not co-occur with rounded nuclei.* (repeated)

(27) *The front rounded medial does not co-occur with low back nuclei*

(28) *The front rounded medial does not co-occur with front nuclei.*

The nuclei in (26e.) are front nasal vowels and the mid central vowel [ə]. The rimes are found in Xuzhou except for *[ɥəŋ]. By comparing (26d.) with the first two rimes in (26e.), we can find that oral and nasal vowels have different phonotactic behaviors. I have argued in the previous chapter that the nasal vowels [ẽ] has the underlying representation /ən/ and the nasal vowel [æ̃] has the underlying representation /ɐn/. The vowel phonemes are central which does not have any conflict with the front value of /y/.

Absence of *[ɥəŋ] in (26e.) is accidental with the following reasons. First, [ɥ] and [ə] can co-occur because [ɥə] in (26e.) is legitimate. Second, [ə] and [-ŋ] can co-occur because [əŋ] in (22) is an acceptable rhyme in Xuzhou. Third, the high front rounded vowel [y] which corresponds to the glide [ɥ] can co-occur with the coda [-ŋ], showing that articulations of the two sounds are not conflicting. Thus the rime [ɥəŋ] shall not be excluded from this language.

3.2.5 Generalizations and summary

I will summarize this section by drawing generalizations from non-occurrence statements. There are two considerations. On the one hand, the generalizations shall express the exact sound features acting on co-occurrence restrictions. On the other hand, the generalizations shall identify crucial rime positions. For instance, [w-] shall not PRECEDE a rounded vowel but [-w] must FOLLOW a rounded vowel. The medial and coda positions are important.

(29) *Phonotactic generalizations I*

• HEIGHT co-occurrence a. High vocoids do not co-occur. b. Low vocoids do not co-occur with high vocoids in rhymes.
• ROUNDEDNESS co-occurrence c. Nucleus and Coda have the same value of roundedness. d. Medial and Nucleus can not both be rounded vocoids.
• BACKNESS co-occurrence e. Non-high front Nucleus does not co-occur with high back Coda. f. The front rounded vocoid does not co-occur with the low back vowel. g. The front rounded vocoid does not co-occur with front vowels.

3.3 Co-occurrences between onsets and rimes

This section examines co-occurrences between onsets and rimes. I am interested in co-occurrence restrictions on adjacent and non-adjacent segments, and the number of syllable constituents that are involved. Subsections are arranged according to places of articulation of onset consonants. Co-occurrences between onsets and apical nuclei are discussed in the last part. Generalizations are drawn as a summary.

3.3.1 Co-occurrences between labial onsets and rimes

Combinations of labial onsets and rimes without medials are presented in (30).

(30) *Combinations of labial onsets and rimes without medials*

a. pe pẽ pɛ pæ̃ pəŋ pɑ pɑŋ pɔ
   p^he p^hẽ p^hɛ p^hæ̃ p^həŋ p^hɑ p^hɑŋ p^hɔ
   me mẽ mɛ mæ̃ məŋ mɑ mɑŋ mɔ
   fe fẽ fɛ fæ̃ fəŋ fɑ fɑŋ *fɔ

b. *pə
   *p^hə
   *mə
   *fə

c. *pow
   *p^how
   *mow
   *fow

d. *ve *vẽ *vɛ *væ̃ *və *vəŋ *vɑ *vɑŋ *vow *vɔ

Syllables in (30a.) can be found in Xuzhou except for *[fɔ]. Since [pɔ] [p^hɔ] [mɔ] are acceptable, labial consonants can precede the non-high back rounded vowel [ɔ]. Thus [f] and [ɔ] shall be compatible. The absence of [fɔ] is considered as an accidental gap.

(30b.) shows labial onsets can not co-occur with the mid central unrounded vowel [ə]. However, the restriction is disabled if the syllable has the velar nasal coda

[-ŋ]. For example, [pəŋ] [pʰəŋ] [məŋ] [fəŋ] in (26a.) are acceptable. It indicates that a single [ə] in the rime is not favored. Since the mid central vowel [ə] is weightless, the monophthongal rime can not form a stressed syllable[14]. Non-cooccurrence can be stated in (31).

(30c.) shows that labial onsets can not precede the rime [ow]. Given that labials can co-occur with the nuclear [ɔ], and both [o] and [ɔ] are non-high back rounded vowels, the nuclear [o] shall not be rejected. Therefore, what is incompatible with the onsets is the coda [-w]. It has the labial articulator as labial onsets do, and it does not occur at the nuclear position. Non-cooccurrence is stated in (32).

It is clear in (30d.) that the voiced labial fricative [v] can not co-occur with any rimes with non-high nuclei. In the previous chapter, I proposed that [v] and [w] are variants of the vowel phoneme /u/. [w] is found to co-occur with non-high nuclei, as shown in (24). Since allophones of the same phoneme are in complementary distribution, [v] does not appear with non-high nuclei.

(31) *Labial onsets do not co-occur with the monophthongal rime [ə].*

(32) *Two labial segments do not co-occur as syllable margins.*

Combinations of labial onsets and rimes with the nuclear [i] or the medial [j-] are displayed in (33).

(33) *Combinations of labial onsets and rimes with [i]/[j-]*

a.	pi	piŋ	pjẽ	pjæ̃	pjə	pjɑ	pjɑŋ	pjɔ
	pʰi	pʰiŋ	pʰjẽ	pʰjæ̃	pʰjə	pʰjɑ	pʰjɑŋ	pʰjɔ
	mi	miŋ	mjẽ	mjæ̃	mjə	mjɑ	*mjɑŋ	mjɔ

b. *pjɛ
*pʰjɛ
*mjɛ

c. *pjow
*pʰjow
*mjow

[14] This consideration owes to Prof. Jiang-King Ping's insight.

d. fi *fiŋ
vi *viŋ

e. *fjɛ *fjẽ *fjæ̃ *fjə *fjɑ *fjɑŋ *fjow *fjɔ
*vjɛ *vjẽ *vjæ̃ *vjə *vjɑ *vjɑŋ *vjow *vjɔ

Onsets in (33a.) are labial stops. All syllables are permissible except for *[mjɑŋ]. Since labial oral stops [p, p^h] can co-occur with the rime [jɑŋ] (e.g. [pjɑŋ] and [p^hjɑŋ]), the labial place of [m] shall not prevent the co-occurrence with [jɑŋ]. Besides, [m] can precede [jɑ] as in [mjɑ] and is compatible with the coda [-ŋ] as in [miŋ], indicating that the nasal manner does not block the co-occurrence. Hence absence of [mjɑŋ] is treated as accidental.

Syllables in (33b.) have the rime [jɛ]. Both [j] and [ɛ] are front vocoids. They are different constituents within a syllable. [j] is Medial and [ɛ] is Nucleus. The data shows that [j] and [ɛ] are incompatible when the syllable has a labial onset. Non-cooccurrence is stated in (34) by addressing the palatal articulation of [j].

Co-occurrence restriction in (33c.) is similar to that in (30c.). Non-cooccurrence statement in (32) is repeated below.

In (33d.), labial fricatives can co-occur with the high front unrounded vowel [i]. Since the labial fricatives can be patterned with the coda [-ŋ] as in [fəŋ] and [fɑŋ] in (26b.), there is no phonetic motivation to reject [fiŋ] and [viŋ]. Thus they are treated as accidental gaps. (33e.) shows that labial fricatives are can not appear with the glide [j-] within a syllable. Non-cooccurrence is stated in (35).

(34) *The palatal Medial after a labial Onset does not co-occur with the low front unrounded Nucleus.*

(32) *Two labial segments do not co-occur as syllable margins.* (repeated)

(35) *Labial fricatives do not co-occur with the palatal Medial.*

Combinations of labial onsets and rimes with the nuclear [u] or the medial [w-] are listed in (36).

(36) *Combinations of labial onsets and rimes with [u]/[w-]*

a. pu *puŋ pwə
p^hu *$p^huŋ$ $p^hwə$
mu *muŋ mwə
fu *fuŋ fwə

b. *pwe *pwẽ *pwɛ *pwæ̃ *pwɑ *pwɑŋ
*p^hwe *$p^hwẽ$ *$p^hwɛ$ *$p^hwæ̃$ *$p^hwɑ$ *$p^hwɑŋ$
*mwe *mwẽ *mwɛ *mwæ̃ *mwɑ *mwɑŋ
*fwe *fwẽ *fwɛ *fwæ̃ *fwɑ *fwɑŋ

c. *vu *vuŋ *vwe *vwẽ *vwɛ *vwæ̃ *vwə *vwɑ *vwɑŋ

Syllables in (36a.) have the nuclear vowel [u] or [ə]. Labial onsets are compatible with the rounded nucleus [u]. Combinations of labials and the rime [uŋ] is absent by accident, because the onset consonants and the nasal coda [-ŋ] can appear in the same syllable as (33a.) shows. While labials reject a single [ə] in the rime, the rejection becomes void when the pre-nuclear glide [w-] is between them. It indicates that the weightless [ə] need another segment in the rime to build a stressed syllable. This is illustrated in syllables with labial onsets and the rime [wə].

All syllables in (36b.-c.) are not found in Xuzhou. The rimes in (36b.) have the medial [w], and their nuclei are non-high vowels other than [ə]. The onset in (33c.) is the voiced labial fricative [v] which disfavors the high back rounded vocoids [u]/[w]. Non-cooccurrences can be stated in (37) by addressing the labial articulation of rounded vocoids. The exception of data in (36a.) can be explained by markedness or phonological weight, which will be elaborated in the next chapter.

(37) *Labial onsets do not co-occur with labial vocoids.*

Combinations of labial onsets and rimes with the nuclear [y] or the medial [ɥ-] are displayed in (38).

(38) *Combinations of labial onsets and rimes with [y]/[ɥ-]*

*py	*pyŋ	*pɥẽ	*pɥæ̃	*pɥə
*p^{h}y	*p^{h}yŋ	*p^{h}ɥẽ	*p^{h}ɥæ̃	*p^{h}ɥə
*my	*myŋ	*mɥẽ	*mɥæ̃	*mɥə
*fy	*fyŋ	*fɥẽ	*fɥæ̃	*fɥə
*vy	*vyŋ	*vɥẽ	*vɥæ̃	*vɥə

None of the above syllables are acceptable in Xuzhou. Since rounded vocoids [y] or [ɥ-] are labial sounds. The statement in (37) can describe the non-cooccurrences, as repeated below.

(37) *Labial onsets do not co-occur with labial vocoids.* (repeated)

3.3.2 Co-occurrences between dental onsets and rimes

Dental onsets are divided into non-stridents [t, t^{h}, n, l] and stridents [ts, ts^{h}, s] because the two sound classes show different phonotactic behaviors. I will begin with the discussion of dental non-stridents.

Combinations of non-stridents and rimes without Medial are shown in (39).

(39) *Combinations of dental non-strident onsets and rimes without medials*

a.

te	*tẽ	tɛ	tæ̃	təŋ	tɑ	tɑŋ	tow	tɔ
t^{h}e	*t^{h}ẽ	t^{h}ɛ	t^{h}æ̃	t^{h}əŋ	t^{h}ɑ	t^{h}ɑŋ	t^{h}ow	t^{h}ɔ
ne	nẽ	nɛ	næ̃	nəŋ	nɑ	nɑŋ	*now	nɔ
le	*lẽ	lɛ	læ̃	ləŋ	lɑ	lɑŋ	low	lɔ

b. *tə
*t^{h}ə
*nə
*lə

Syllables in (39a.) are found in Xuzhou except for *[tẽ] *[t^{h}ẽ] *[lẽ] and *[now]. Absence of these four syllables is viewed as accidental for the following reasons. First, dentals can be patterned with the mid front unrounded vowel [e], e.g. [te] [t^{h}e]

[le]. Second, the consonants accept a nasal vowel nucleus, e.g. [tæ̃] [tʰæ̃] [læ̃]. Since the vowel [e] and the nasal feature are compatible with dental non-stridents, [tẽ] [tʰẽ] [lẽ] are conceivably legitimate. Third, both the dental obstruents and sonorant can precede the rime [ow], e.g. [tow] [tʰow] [low], indicating that dental non-stridents are compatible with [ow].

Syllables in (39b.) are not acceptable in Xuzhou. They are systematic gaps. It is similar to the case in (30b.) where labials can not be patterned with a single [ə] in the rime. Non-cooccurrence can be stated as follows.

(40) *Dental onsets do not co-occur with the monophthongal rime [ə].*

Combinations of dental non-strident onsets and rimes with the nuclear [i] or the medial [j-] are listed in (41). According to Su and Lü (1996:4), when the dental /n/ precedes a high front vocoid, the nasal becomes the palatal [ɲ]. The phonotactic behavior of [ɲ] is similar to that of other dental non-stridents. It is discussed in this subsection but not in the subsection of palatal onsets.

(41) *Combinations of dental non-strident onsets and rimes with [i]/[j-]*

a.	ti	tiŋ	*tjẽ	tjæ̃	tjə	tjɑ	tjɑŋ	tjow	tjɔ
	tʰi	tʰiŋ	*tʰjẽ	tʰjæ̃	tʰjə	*tʰjɑ	tʰjɑŋ	*tʰjow	tʰjɔ
	li	liŋ	ljẽ	ljæ̃	ljə	ljɑ	ljɑŋ	ljow	ljɔ
	ni	niŋ	* njẽ	njæ̃	njə	*njɑ	njɑŋ	njow	njɔ
	(ɲi)	(ɲiŋ)		(ɲjæ̃)	(ɲjə)		(ɲjɑŋ)	(ɲjow)	(ɲjɔ)

b. *tjɛ
*tʰjɛ
*ljɛ
*njɛ

Syllables in (41a.) are found in Xuzhou except for *[tjẽ] *[tʰjẽ] *[tʰjɑ] *[tʰjow] *[njẽ] and *[njɑ]. I treat them as accidental gaps because other consonants of the same dental non-strident class can co-occur with the rimes [jẽ] [jɑ] [jow]. For instance, [l] and [jẽ] form a legitimate syllable [ljẽ], [t] or [l] can form legitimate

syllables with [jɑ], and there are the well-formed [tjow] and [ljow].

In (41b.), the rime [jɛ] has two front segments. [j] and [ɛ] are different constituents within a syllable. [j] is Medial and [ɛ] is Nucleus. The data shows that their combination is disfavored by dental onsets. The phonological pattern is similar to (33b.) where labial onsets do not accept the rime *[jɛ]. Non-occurrence can be stated in (42).

(42) *The palatal Medial after a labial Onset does not co-occur with the low front unrounded Nucleus.* (repeated)

Combinations of dental non-strident onsets and rimes with the nuclear [u] or the medial [w-] are given in (43). In (43a.), all syllables except for *[nwe] *[lwe] *[nwẽ] *[tʰwaŋ] *[nwaŋ] *[lwaŋ] are found in Xuzhou. The exceptions are taken as accidental gaps because the rimes [we] [wẽ] [waŋ] are not rejected by other dental non-stridents. For instance, [twe] [twẽ] [twaŋ] are legitimate syllables.

(43) *Combinations of dental non-strident onsets and rimes with [u]/[w-]*

a.	tu	tuŋ	twe	twẽ	twæ̃	twə	twaŋ
	tʰu	tʰuŋ	tʰwe	tʰwẽ	tʰwæ̃	tʰwə	*tʰwaŋ
	nu	nuŋ	*nwe	*nwẽ	nwæ̃	nwə	*nwaŋ
	lu	luŋ	*lwe	lwẽ	lwæ̃	lwə	*lwaŋ

b.	*twɛ	*twɑ
	*tʰwɛ	*tʰwɑ
	*nwɛ	*nwɑ
	*lwɛ	*lwɑ

In (43b.), the nuclear vowels are [ɛ] and [ɑ]. [ɛ] is the lowest front oral vowels, and [ɑ] is a low back vowel. It can be hypothesized that dental non-strident onsets disfavor a rime having a high glide and a low vowel. However, syllables like [tjɑ] and [ljɑ] in (40a.) are acceptable in Xuzhou. The rime [jɑ] consists of a high glide and a low vowel. This evidence goes against the hypothesis. Thus absence of syllables in (43b.) is treated as accidental.

Combinations of dental non-strident onsets and rimes with the nuclear [y] or the medial [ɥ-] are displayed in (44). The palatal nasal [ȵ] is discussed here because it is an allophone of the dental nasal /n/.

(44) *Combinations of dental non-strident onsets and rimes with [y]/[ɥ-]*

a.	*ty	*tyŋ	*tɥẽ	*tɥæ̃	*tɥə
	*t^{h}y	*t^{h}yŋ	*t^{h}ɥẽ	*t^{h}ɥæ̃	*t^{h}ɥə
b.	ly	*lyŋ	*lɥẽ	*lɥæ̃	*lɥə
	ny	*nyŋ	*nɥẽ	*nɥæ̃	*nɥə
	(ȵy)				

(44) carries two messages. First, dental stops do not co-occur with either [y] or [ɥ-] but dental nasal or lateral can. Stops are obstruents and nasals/lateral approximant are sonorants. Sonorants have greater sonority than obstruents (Prince and Smolensky 2004:151). Cross-linguistically, low-sonority onsets are preferred. Other things being equal, an onset stop is more favored than an onset sonorant (Smith 2003:3). Therefore, missing syllables in (44a.) are taken as accidental gaps.

The second message is that dentals can co-occur with the vowel [y] but not the glide [ɥ-]. Both [y] and [ɥ] are realized from the vowel /y/. Since vowels have high sonority than consonants, they prefer the syllable peak position to the syllable margin position. Absence of [ɥ] can be explained by its medial position. The gaps are systematic. Non-occurrence can be stated in (45).

(45) · *Dentals do not co-occur with the high front rounded glide.*

Next, I will look into dental strident onsets [ts, ts^{h}, s]. Combinations of dental strident onsets and rimes without medials are presented in (46). All syllables in (46a.) are acceptable in Xuzhou, whereas all syllables in (46b.) are not. The rime in (46b.) consists of the mid central unrounded vowel [ə] only. It is similar to the data in (39b.) where dental non-stridents can not appear with the monophthongal rime [ə]. Non-occurrence can be described by the statement in (40).

(46) *Combinations of dental strident onsets and rimes without medials*

a.	tse	tsẽ	tsɛ	tsæ̃	tsəŋ	tsɑ	tsɑŋ	tsow	tsɔ
	ts^he	$ts^hẽ$	$ts^hɛ$	$ts^hæ̃$	$ts^həŋ$	$ts^hɑ$	$ts^hɑŋ$	ts^how	$ts^hɔ$
	se	sẽ	sɛ	sæ̃	səŋ	sɑ	sɑŋ	sow	sɔ

b. *tsə
*$ts^hə$
*sə

(40) *Dental onsets do not co-occur with a light rime [ə].* (repeated)

Combinations of dental strident onsets and rimes with high vowel nuclei or medials are shown in (47).

(47) *Combinations of dental strident onsets and rimes with medials*

a.	*tsi	*tsiŋ	*tsjẽ	*tsjɛ	*tsjæ̃	*tsjə	*tsjɑ	*tsjɑŋ	*tsjow	*tsjɔ
	*ts^hi	*$ts^hiŋ$	*$ts^hjẽ$	*$ts^hjɛ$	*$ts^hjæ̃$	*$ts^hjə$	*$ts^hjɑ$	*$ts^hjɑŋ$	*ts^hjow	*$ts^hjɔ$
	*si	*siŋ	*sjẽ	*sjɛ	*sjæ̃	*sjə	*sjɑ	*sjɑŋ	*sjow	*sjɔ

b.	tsu	tsuŋ	tswe	tswẽ	*tswɛ	tswæ̃	tswə	*tswɑ	*tswɑŋ
	ts^hu	$ts^huŋ$	ts^hwe	$ts^hwẽ$	*$ts^hwɛ$	$ts^hwæ̃$	$ts^hwə$	*$ts^hwɑ$	*$ts^hwɑŋ$
	su	suŋ	swe	swẽ	*swɛ	swæ̃	swə	*swɑ	*swɑŋ

c.	*tsy	*tsyŋ	*tsɥẽ	*tsɥæ̃	*tsɥə
	*ts^hy	*$ts^hyŋ$	*$ts^hɥẽ$	*$ts^hɥæ̃$	*$ts^hɥə$
	*sy	*syŋ	*sɥẽ	*sɥæ̃	*sɥə

Rimes in (47a.) and (47c.) have the high front unrounded vowel [i] or glide [j-], or the high front rounded vowel [y] or glide [ɥ-]. None of them can follow the dental stridents. Non-cooccurrence is stated in (48).

(48) *Dental stridents do not co-occur with high front vocoids.*

Rimes in (47b.) have the high back rounded vowel [u] or pre-nuclear glide [w-]. All can co-occur with dental strident onsets except for [wɛ] [wɑ] and [wɑŋ]. I treat them as accidental gaps because there is no phonetic motivation to rule them out. If

the height difference between the glide and the vowel is vital to *[wɛ] *[wɑ] and *[wɑŋ], [tswæ̃] shall not be legitimate because [w-] is high and [æ̃] is low. If [tswæ̃] was allowed because of a nasal sound in the rime, *[tswɑŋ] should also be legitimate due to the nasal [ŋ]. Since both the place of height and the manner of nasal can not explain their absence, [wɛ] [wɑ] and [wɑŋ] are potentially acceptable by dental strident onsets.

3.3.3 Co-occurrences between retroflex onsets and rimes

Combinations of retroflex onsets and rimes without medials are presented in (49).

(49) *Combinations of retroflex onsets and rimes without medials*

a.	tʂẽ	tʂæ̃	tʂə	tʂəŋ	*tʂɑ	tʂɑŋ	tʂow	tʂɔ
	tʂʰẽ	tʂʰæ̃	tʂʰə	tʂʰəŋ	*tʂʰɑ	tʂʰɑŋ	tʂʰow	tʂʰɔ
	ʂẽ	ʂæ̃	ʂə	ʂəŋ	ʂɑ	ʂɑŋ	ʂow	ʂɔ
	ɻẽ	ɻæ̃	ɻə	ɻəŋ	*ɻɑ	ɻɑŋ	ɻow	ɻɔ

b.	*tʂe	*tʂɛ
	*tʂʰe	*tʂʰɛ
	*ʂe	*ʂɛ
	*ɻe	*ɻɛ

All syllables in (49a.) are found in Xuzhou except for *[tʂɑ] *[tʂʰɑ] *[ɻɑ]. Since the voiceless retroflex fricative [ʂ] can be followed by the low back unrounded vowel [ɑ], the retroflex consonants as a natural class do not reject the nucleus [ɑ]. Thus the absence of [tʂɑ] [tʂʰɑ] [ɻɑ] are viewed as accidental gaps.

The nuclei in (49b.) are non-high front vowels, which are disfavored by the retroflex onsets. The front nasal vowels [ẽ, æ̃] can follow the retroflexes freely because they are realized from /ən/ and /ɐn/ respectively. The phonemes are central but not front. Non-cooccurrence is stated below.

(50) *Retroflex onsets do not co-occur with non-high front nuclei.*

Combinations of retroflex onsets and rimes with high vowel nuclei or medials are displayed in (51). Rimes in (51a.) and (51c.) have the high front unrounded vowel [i] or glide [j-], or the high front rounded vowel [y] or glide [ɥ-]. All syllables are not allowed in Xuzhou. Non-cooccurrence is stated in (52).

(51) *Combinations of retroflex onsets and rimes with medials*

a.	*tʂi	*tʂiŋ	*tʂjẽ	*tʂjɛ	*tʂjæ̃	*tʂjə	*tʂjɑ	*tʂjɑŋ	*tʂjow	*tʂjɔ
	*tʂʰi	*tʂʰiŋ	*tʂʰjẽ	*tʂʰjɛ	*tʂʰjæ̃	*tʂʰjə	*tʂʰjɑ	*tʂʰjɑŋ	*tʂʰjow	*tʂʰjɔ
	*ʂi	*ʂiŋ	*ʂjẽ	*ʂjɛ	*ʂjæ̃	*ʂjə	*ʂjɑ	*ʂ jɑŋ	*ʂjow	*ʂjɔ
	*ɻi	*ɻiŋ	*ɻjẽ	*ɻjɛ	*ɻjæ̃	*ɻjə	*ɻjɑ	*ɻ jɑŋ	*ɻjow	*ɻjɔ
b.	tʂu	tʂuŋ	tʂwe	tʂwẽ	tʂwɛ	tʂwæ̃	tʂwə	tʂwɑ	tʂwɑŋ	
	tʂʰu	tʂʰuŋ	tʂʰwe	tʂʰwẽ	tʂʰwɛ	tʂʰwæ̃	tʂʰwə	tʂʰwɑ	tʂʰwɑŋ	
	ʂu	*ʂuŋ	ʂwe	ʂwẽ	ʂwɛ	ʂwæ̃	ʂwə	ʂwɑ	ʂwɑŋ	
	ɻu	ɻuŋ	ɻwe	*ɻwẽ	*ɻwɛ	ɻwæ̃	ɻwə	*ɻwɑ	*ɻwɑŋ	
c.	*tʂy	*tʂyŋ	*tʂɥẽ	*tʂɥæ̃	*tʂɥə					
	*tʂʰy	*tʂʰyŋ	*tʂʰɥẽ	*tʂʰɥæ̃	*tʂʰɥə					
	*ʂy	*ʂyŋ	*ʂɥẽ	*ʂɥæ̃	*ʂɥə					
	*ɻy	*ɻyŋ	*ɻɥẽ	*ɻɥæ̃	*ɻɥə					

(52) *Retroflex onsets do not co-occur with high front vocoids.*

Rimes in (51b.) have the high back rounded vowel [u] or pre-nuclear glide [w-]. All syllables are found in Xuzhou except for *[ʂuŋ] *[ɻwẽ] *[ɻwɛ] *[ɻwɑ] *[ɻwɑŋ]. Since [tʂ] [tʂʰ] [ɻ] can appear before [uŋ] and [tʂ] [tʂʰ] [ʂ] can precede [wẽ] [wɛ] [wɑ], retroflex consonants as a natural class do not reject the four rimes. The exceptions are taken as accidental gaps.

3.3.4 Co-occurrences between palatal onsets and rimes

Combinations of palatal obstruents [tɕ, tɕʰ, ɕ] and rimes are presented in (53). Rimes in (53a.) do not have medial glides. They can not co-occur with the palatal onsets. Rimes in (53b.) have the high front unrounded vowel [i] or glide [j-]. All of them can follow the palatal onsets. Rimes in (53c.) have the high back rounded vowel [u] or glide [w-]. None of them are compatible with the palatals. Rimes in (53d.) have the high front rounded vowel [y] or [ɥ-], and all can co-occur with the palatals. Non-cooccurrences can be stated in (54–55).

(53) *Combinations of palatal obstruent onsets and rimes*

a.	*tɕe	*tɕẽ	*tɕɛ	*tɕæ̃	*tɕə	*tɕəŋ	*tɕɑ	*tɕɑŋ	*tɕow	*tɕɔ
	*tɕʰe	*tɕʰẽ	*tɕʰɛ	*tɕʰæ̃	*tɕʰə	*tɕʰəŋ	*tɕʰɑ	*tɕʰɑŋ	*tɕʰow	*tɕʰɔ
	*ɕe	*ɕẽ	*ɕɛ	*ɕæ̃	*ɕə	*ɕəŋ	*ɕɑ	*ɕɑŋ	*ɕow	*ɕɔ
b.	tɕi	tɕiŋ	tɕjẽ	tɕjɛ	tɕjæ̃	tɕjə	tɕjɑ	tɕjɑŋ	tɕjow	tɕjɔ
	tɕʰi	tɕʰiŋ	tɕʰjẽ	tɕʰjɛ	tɕʰjæ̃	tɕʰjə	tɕʰjɑ	tɕʰjɑŋ	tɕʰjow	tɕʰjɔ
	ɕi	ɕiŋ	ɕjẽ	ɕjɛ	ɕjæ̃	ɕjə	ɕjɑ	ɕjɑŋ	ɕjow	ɕjɔ
c.	*tɕu	*tɕuŋ	*tɕwe	*tɕwẽ	*tɕwɛ	*tɕwæ̃	*tɕwə	*tɕwɑ	*tɕwɑŋ	
	*tɕʰu	*tɕʰuŋ	*tɕʰwe	*tɕʰwẽ	*tɕʰwɛ	*tɕʰwæ̃	*tɕʰwə	*tɕʰwɑ	*tɕʰwɑŋ	
	*ɕu	*ɕuŋ	*ɕwe	*ɕwẽ	*ɕwɛ	*ɕwæ̃	*ɕwə	*ɕwɑ	*ɕwɑŋ	
d.	tɕy	tɕyŋ	tɕɥẽ	tɕɥæ̃	tɕɥə					
	tɕʰy	tɕʰyŋ	tɕʰɥẽ	tɕʰɥæ̃	tɕʰɥə					
	ɕy	ɕyŋ	ɕɥẽ	ɕɥæ̃	ɕɥə					

(54) *Palatal onsets do not co-occur with non-high nuclei.*

(55) *Palatal onsets do not co-occur with high back rounded vocoids.*

3.3.5 Co-occurrences between velar onsets and rimes

Combinations of velar onsets and rimes are displayed in (56).

(56) *Combinations of velar onsets and rimes*

a.	ke	kẽ	kɛ	kæ̃	kə	kəŋ	kɑ	kɑŋ	kow	kɔ
	k^he	$k^hẽ$	$k^hɛ$	$k^hæ̃$	$k^hə$	$k^həŋ$	$k^hɑ$	$k^hɑŋ$	k^how	$k^hɔ$
	xe	xẽ	xɛ	xæ̃	xə	xəŋ	xɑ	xɑŋ	xow	xɔ
b.	*ki	*kiŋ	*kjẽ	*kjɛ	*kjæ̃	*kjə	*kjɑ	*kjɑŋ	*kjow	*kjɔ
	*k^hi	*$k^hiŋ$	*$k^hjẽ$	*$k^hjɛ$	*$k^hjæ̃$	*$k^hjə$	*$k^hjɑ$	*$k^hjɑŋ$	*k^hjow	*$k^hjɔ$
	*xi	*xiŋ	*xjẽ	*xjɛ	*xjæ̃	*xjə	*xjɑ	*xjɑŋ	*xjow	*xjɔ
c.	ku	kuŋ	kwe	kwẽ	kwɛ	kwæ̃	kwə	kwɑ	kwɑŋ	
	k^hu	$k^huŋ$	k^hwe	$k^hwẽ$	$k^hwɛ$	$k^hwæ̃$	$k^hwə$	$k^hwɑ$	$k^hwɑŋ$	
	xu	xuŋ	xwe	xwẽ	xwɛ	xwæ̃	xwə	xwɑ	xwɑŋ	
d.	*ky	*kyŋ	*kɥẽ	*kɥæ̃	*kɥə					
	*k^hy	*$k^hyŋ$	*$k^hɥẽ$	*$k^hɥæ̃$	*$k^hɥə$					
	*xy	*xyŋ	*xɥẽ	*xɥæ̃	*xɥə					

Rimes in (56a.) do not have medials and their nuclei are non-high vowels. They are compatible with the velar onsets. Rimes in (56b.) have the high front unrounded vowel [i] or glide [j-]. They never co-occur with the velar onsets. Rimes in (56c.) have the high back rounded vowel [u] or glide [w-]. All of them can follow the velar onsets. Rimes in (56d.) have the high front rounded vowel [y] or glide [ɥ-]. Their co-occurrences with the velar onsets are not found. Non-cooccurrence can be stated in (57).

(57) *Velar onsets do not co-occur with high front vocoids.*

3.3.6 Co-occurrences between onsets and rimes with apical nuclei

All vowels and glides discussed in the previous sub-sections are laminal, whose active articulator is the tongue body. In this section, I will examine combinations of onset consonants and apical nuclei [ɹ̩, ɻ̩], the syllabic approximants whose articulation involves movement of the tongue tip.

The apical nuclei never co-occur with any medial or coda. Each syllabic approximant forms an entire rime. Their distributions in Xuzhou syllables are narrow. (58) provides combinations of onset consonants and apical nuclei.

(58) *Co-occurrences between onsets and apical vowels*

a.	*pɹ̩	*tɹ̩	tsɹ̩	*tʂɹ̩	*tɕɹ̩	*kɹ̩
	*pʰɹ̩	*tʰɹ̩	tsʰɹ̩	*tʂʰɹ̩	*tɕʰɹ̩	*kʰɹ̩
	*mɹ̩	*nɹ̩	sɹ̩	*ʂɹ̩	*ɕɹ̩	*xɹ̩
	*fɹ̩	*lɹ̩		*ɻɹ̩	*ȵɹ̩	
	*vɹ̩					
b.	*pɻ̩	*tɻ̩	*tsɻ̩	tʂɻ̩	*tɕɻ̩	*kɻ̩
	*pʰɻ̩	*tʰɻ̩	*tsʰɻ̩	tʂʰɻ̩	*tɕʰɻ̩	*kʰɻ̩
	*mɻ̩	*nɻ̩	*sɻ̩	ʂɻ̩	*ɕɻ̩	*xɻ̩
	*fɻ̩	*lɻ̩		ɻ̩ɻ̩	*ȵɻ̩	
	*vɻ̩					

(58a.) illustrates that [ɹ̩] can only follow dental stridents [ts, tsʰ, s], and (58b.) illustrates that [ɻ̩] can only follow retroflexes [tʂ, tʂʰ, ʂ, ɻ̩]. Legitimate co-occurrences between apical nuclei and their preceding consonants have strong phonetic motivation. The onsets and the nuclei share the same places of articulation. In terms of places of articulation, dentals and retroflexes are coronal sounds. Considering the narrow distribution of [ɹ̩, ɻ̩] and their close relations with the onsets, the statement is made in terms of co-occurrence instead of non-cooccurrence. I view the syllable [ɻ̩ɻ̩] consisting of one sound but not two sounds, and thus exclude it from the following statement.

(59) *Syllabic approximants only co-occur with coronal stridents.*

3.3.7 Generalizations and summary

Generalizations are drawn in (60) as a summary of co-occurrence and non-cooccurrence statements in the above discussion.

(60) *Phonotactic generalizations II*

• LABIAL co-occurrence a. Labial consonants do not co-occur with high rounded vocoids. b. Labial fricatives do not co-occur with high front glides.
• CORONAL co-occurrence c. Coronal continuants do not co-occur with high front vocoids. d. Syllabic approximants only co-occur with coronal continuants. e. Retroflex consonants do not co-occur with front vowels. f. Anterior consonants do not co-occur with the monophtongal rime [ə].
• PALATAL and VELAR co-occurrence g. Palatal consonants only co-occur with high front vocoids. h. Palatal glides do not occur between non-palatal onsets and the low front vowel. i. Velar consonants do not co-occur with high front vocoids.

The relation between 'coronal' and 'palatal' in (60) needs to be clarified. Following Gussenhoven and Jacobs (1998:75) and Odden (2005:28), I define *coronal* as segments articulated with the blade or tip of the tongue raised from the neutral position, and treat palatal consonants as [coronal]. Among coronal segments, palatals are produced with the tongue blade, and dentals/retroflexes are produced with the tongue tip. In Xuzhou, palatals show different phonotactic behaviors from others. Therefore, I use 'coronal' for dentals and retroflexes, and display 'palatal co-occurrence' independently.

The consonant class 'coronal continuants' involves dental stridents, retroflex stridents, and the retroflex approximant. The inclusion of affricates and exclusion of the lateral shall be explained. First, an affricate is a sequence of a stop followed by a

homorganic fricative (Ladefoged 2006:66). In Xuzhou, the dental or retroflex affricates at the onset position can extend to produce syllabic approximants at the nuclear position. They are grouped into the continuant class because of this phonotactic behavior. Second, a lateral is articulated with airstream obstruction at a point along the center of the oral tract (Ladefoged 2006:15). I treat the lateral in Xuzhou as [-continuant] because it behaves different from other continuants such as [s, ɻ] but similar to stops such as [t, t^h, n].

Chapter 4 OT Account for Xuzhou phonotactics

This chapter is devoted to explain Xuzhou phonotactics by adopting Optimality Theory (OT; Prince and Smolensky 1993/2004). I will briefly introduce the basic concepts of OT and evaluate its merits over previous approaches. The focus of this chapter is an optimality-theoretic analysis of phonotactic generalizations drawn in Chapter 3. I argue that the phonotactic behaviors result from a specific hierarchy of universal constraints. The ranking of constraints is put forward in the end.

4.1 Optimality Theory

Optimality Theory is a linguistic model proposing that output forms of language arise from interaction of conflicting constraints. It makes the following assumption. Universal Grammar (UG) provides a set of general constraints. The constraints are intrinsically conflicting and violable. They are operative in individual languages. The grammar of a language resolves the conflicts by ranking the universal constraints in a domination hierarchy. Languages differ in the way how constraints are ranked.

4.1.1 Basic concepts

Optimality Theory is an input-output mechanism recognizing a direct mapping between two levels of representations. It has three components, i.e. Lexicon, Generator and Evaluator. Lexicon (LEX) contains lexical representations which are inputs. Generator (GEN) contains information about the representational primitives and their universally unchangeable relations (Prince and Smolensky 2004: 5), and generates output candidates. Evaluator (EVAL) contains a set of ranked constraints, evaluates the constraint violations (or the harmonic values) of candidates, and selects the candidate that incurs least serious violations to be the optimal output.

Constraints and their ranking in EVAL play a principal role to explain how languages are structured. *Universality* and *violability* are two properties of constraints (Kager 1999:10-12). Universality states that the phonological markedness constraints shall have typological motivation, or be phonetically grounded in

articulation or perception. Violability speaks of constraints as violable, but violations shall be minimal. *Strict domination* is an essential property of rankings. The notion of 'strict' says that violation of higher-ranked constraints is fatal, and it can not be compensated for by satisfaction of lower-ranked constraints (Kager 1999:22). The notion of 'domination' expresses the relation of UG constraints in individual languages.

4.1.2 Comparison with rule-based theories

The rule-based theories in Generative Phonology are established in Chomsky and Halle (1968) and developed thereafter. The core concepts are rewrite rules and derivation. The structural changes and structural conditions are incorporated in rules. Rules are applied during a serial derivation. Structural changes take place when the conditioning environments are met. Rule application gives rise to a new phonological representation. An underlying form passes through a number of intermediate representations on the way to its surface form.

The rule-based approach has two deficiencies. First, it fails to recognize the functional unity of phonological rules. Linguistically significant generalization is attained via structural sameness. Rules are collapsible only when they have structural similarity and are adjacently ordered in the stages of derivation. However, Kisseberth (1970:293) argues that the unit of a set of rules may not depend on the similarity of structural descriptions, but lie on the similarity of their function. The study of Yawelmani shows that two phonological processes, *consonant reduction* and *vowel epenthesis*, are in action to avoid two-consonant clusters at the word margin (*#CC, *CC#) or three-consonant clusters (*CCC). The rules are structurally different and adjacent ordering is unnecessary, but they have the same effect. This kind of rule conspiracy is not accounted for in rule-based theories.

Second, the rule-based approach causes the Duplication Problem (Kenstowicz and Kisseberth 1977:136-145). It distinguishes morpheme-structure rules (MSRs) from phonological rules. MSRs are operated within a morpheme. They supply

predictable feature values which are not specified in the lexicon. The application is prior to that of phonological rules. In Yawelmani, the feature [back] in the vowel system is predictable. Segment-structure rules are a subset of MSRs which assign [+back] to vowels that are [+round] or [-high]. In the later stage, the phonological rule of vowel harmony assigns [+round] to an unrounded vowel when it is preceded by a rounded vowel of the same height. However, when /i/ is rounded by harmony, it changes to [u] rather than *[y]. The MSRs predict that all rounded vowels are back, but they are disabled in the proper of phonological rules. The harmony rule has to be revised to include this information. Repetition of information causes the Reduplication Problem. It makes the phonology of a language more complex, and reduces linguistic significance of generalizations.

While rule conspiracies are not accounted for in rule-based theories, it is within the scope of Optimality Theory (Kager 1999:87). The success of OT rests upon two factors. First, structural well-formedness is defined on surface forms. Markedness constraints in OT require that output forms meet the criterion of well-formedness. The structural changes aim to satisfy the constraints as much as possible. They are functionally unified. Second, OT separates structural changes from their triggers. GEN produces a variety of output candidates with different structural configurations. All are sent to EVAL for evaluation. Different languages could select different optimal outputs to avoid violation of the same constraint. Although the phonological processes are distinct, their ultimate goal is the same.

OT solves the Duplication Problem vacuously because the direct input-output mapping avoids it. In rule-based theories, MSRs functions to supply feature values to the lexicon and provides underlying representations to phonological rules (Kenstowicz and Kisseberth 1977:136). The problem happens because MSRs can not apply in phonology. In OT, morphological well-formedness constraints are ranked in a single hierarchy together with syllable well-formedness constraints (Kager 1999:122). Both types evaluate the same set of output candidates. Since OT only recognizes two representations: input and output, there is no intermediate stage. As a result, OT does not bother to enable or disable a constraint at certain stages.

4.1.3 Comparison with constraint-and-repair theories

Constraint-and-repair theories emerge before Optimality Theory. Phonologists notice the problems such as rule conspiracy and duplication, and introduce surface-unviolated constraints to block phonological processes or to trigger application of repair strategies (Kager 1999:56-57). Research in this line still sticks to the derivational concept. Various proposals are made for interaction between constraints and rules. *Theory of Constraints and Repair Strategies* (Paradis 1988) and *Persistent Rule Theory* (Myers 1991) are two representatives.

Paradis (1988:75-97) argues that morphology and phonology are interactive. Phonological constraints can be effective in the lexicon. A constraint does not accomplish any change. It either blocks the phonological processes whose outputs would violate this constraint, or triggers application of a phonology operation, *repair strategy*. Repair strategies are only responsible for constraints, and they are context-free. Phonological processes that are not repair strategies could have context-sensitive rules, whose description includes both the structural change and the structural condition.

Myers (1991:315-344) invokes the notion of Persistent Rules. A persistent rule functions the same as a constraint. It affects the phonological elements such as segments, syllables or foot structures without reference to their environments, whereas an ordered rule includes the reference. A persistent rule is unordered and can apply whenever the structural description is met. It is an expression of language-particular restrictions on the structure of phonological elements. If a persistent rule produces a structure that is impossible in the language, its output is an intermediate representation which will be repaired by other means.

As the representative models show, constraint-and-repair theories can solve the problems in rule-based theories by stipulating a context-free constraint or persistent rule that is effective both in the lexicon and in the proper of phonological processes. However, theoretical complexities arise due to co-existence of constraints and rules. On the one hand, theoretical apparatus are increased by adding constraints and repair

strategies to rules and rule orderings. On the other hand, implementation of constraints is cumbersome. Surface-unviolated constraints can be violated at some intermediate stages, and repair strategies shall be triggered to make the structure well-formed.

Optimality Theory is eligible to do the job of constraint-and-repair strategies, and it is a simpler model by limiting grammatical interactions to constraints only (Kager 1999:57). First, OT eliminates structural changes. The function GEN supplies all structures. The desirable form is somewhere in the pool of output candidates. Second, constraints in OT exist in Universal Grammar (UG). The functions EVAL in individual languages have the same set of universal constraints. They give rise to different grammars in the consequence of language-specific rankings.

Two major properties *Generality* and *Universality* make OT outstanding (Prince and Smolensky 2004:246-247). While constraint-and-repair theories define well-formedness by constraints and rules, OT only uses constraints to define it. Hence the constraints in OT are more general. In constraint-and-repair theories, if a constraint in one language (L1) is surface-violated in the other (L2), L2 does not recognize such a constraint. OT does not have a distinction of violable/inviolable constraints. All constraints are violable, and they are incorporated in the EVAL functions of all languages. Therefore, the constraints in OT are universal.

4.1.4 Summary

To sum up, OT views grammar as a device to select the most harmonic output from an infinite candidate set by means of language-specific rankings of universal constraints. This model is superior to rule-based theories because it can solve the problems that root in application of rules and rule orderings. It exceeds constraint-and-repair theories by providing a simpler theoretical model without reducing the explanatory power.

4.2 Previous studies on phonotactics within a syllable

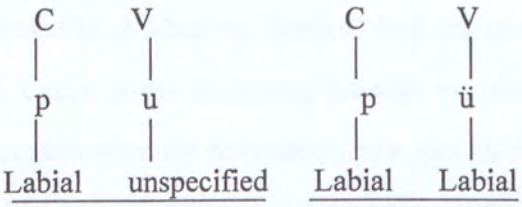
The phonotactic constraints within a Chinese syllable have been discussed within the framework of auto-segmental phonology. Co-occurrence restrictions are found to exist between (a) onset and glide (*[twa], Standard Chinese), (b) onset and nucleus (*[fi], Standard Chinese), (c) onset and coda (*[k^{w}au], Cantonese), (d) glide and nucleus (*[djy], Standard Chinese) as well as (e) nucleus and coda (*[up], Cantonese). I will mainly review the studies of Cantonese phonotactics in order to introduce different approaches by addressing the same issue.

There have been three major proposals. Yip (1988) uses the syllable structure building rule to explain co-occurrence restrictions in Cantonese. In the study of the constraints on the co-occurrence between rounded vowels and the labial consonants in Cantonese, Yip (1988:81-82) claims that the [+rounded] feature of back vowels is unspecified until the redundancy rule assigns this value to the vowels. This analysis accounts for the different distributions of front and back rounded vowels in relation to labial consonants. She argues that the Obligatory Contour Principle (OCP; McCarthy 1986) plays a role of the Morpheme Structure Constraint (MSC) on labials, and it blocks the co-occurrence of two adjacent segments with the same feature value. The example in (1) is cited from Yip (1988:82).

At the point of creating onsets, only the front vowels are specified as [+rounded], which automatically entails the assignment of a labial articulator node, i.e. Labial, whereas the back vowel's roundedness feature is unspecified. In *Step* (i), *pu* is permissible but *pü* is not because the latter violates the OCP. The redundancy rules in *Step* (ii) are applied to add values to the unspecified features. [+rounded] is assigned to the back vowel and consequently generates the labial articulator node. In *Step* (iii), the back vowel is characterized as Labial. Thus, *-up* is prohibited. But if *n* is the coda, the syllable is allowed because the Coronal articulator of the coda does not conflict with the nucleus Labial. Therefore, Cantonese has [pun] but does not accept *[pup] or *[pü].

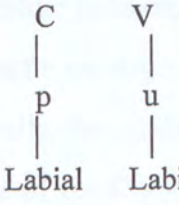
(1) *Syllable structure building rule in Yip (1988:82)*

(i) *Create onsets:*

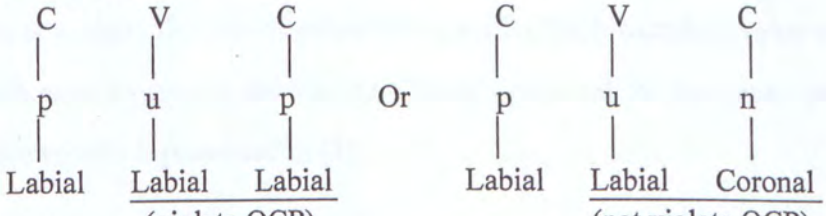


OCP: (not violate OCP) (violate OCP)

(ii) *Redundancy rules:*



(iii) *Create codas:*



OCP: (violate OCP) (not violate OCP)

Zhang (1991) makes a further step from Yip's analysis and studies the operation of the OCP on the co-occurrence between the labialized velar consonant and the back rounded vowel (e.g. *[k^{w}au]), and the co-occurrence between the labialized velar consonant and the labial consonant (e.g. *[k^{w}ip]). He suggests that the difference between the major and secondary articulatory features influences the application of the OCP or the redundancy rules. His arguments can be summarized in (2).

(2) *Modified syllable structure building rule in Zhang (1991:507)*

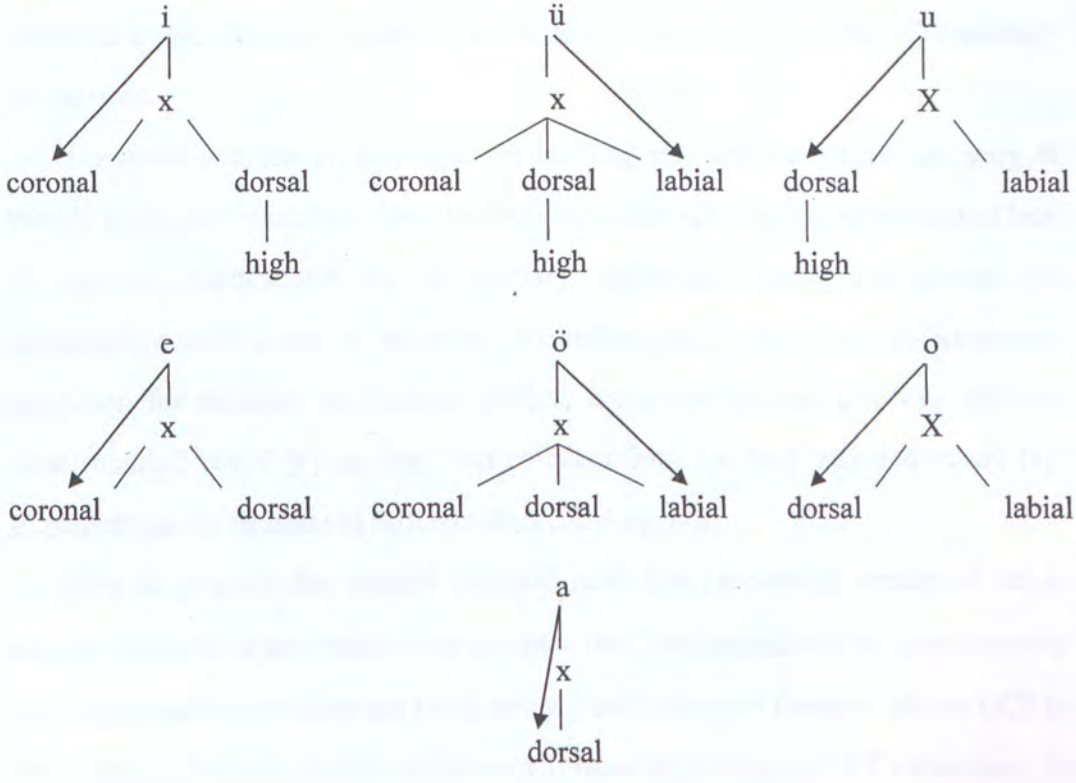
a. If [labial] is the major articulatory feature (e.g. [p] in [pau]), the application follows Yip's order, and the OCP operates before the redundancy rules.

b. If [labial] is the secondary articulatory feature (e.g. [k^{w}] in *[k^{w}au]), the redundancy rules are applied after building the coda, and the OCP is applied after the redundancy rules

The syllable [pau] is found in Cantonese. Labial is the major articulatory feature of *p*. According to (2a.), the OCP operates before the redundancy rule assigns the feature value to *u*. Thus no identical features co-occur. The syllable *[k^{w}au] is not allowed. Labial is the secondary articulatory feature of *k^{w}*. According to (2b.), the OCP is applied after the redundancy rule, that is, after *u* obtains the Labial node. The labial-labial co-occurrence causes violation, and *[k^{w}au] is ruled out.

Cheng (1990) studies the co-occurrence restrictions in Cantonese by appealing to the feature geometry of vowels. Cheng (1990:111) proposes that vowels should be specified for the degree of stricture and thus there are major and/or minor articulators. Specifically, the difference between front and back vowels is represented by the presence of the Coronal articulator for the [+front] vowels and its absence for the non-front vowels. The Dorsal articulator is responsible for [+high], and its absence indicates non-high. The Labial articulator specifies the [+rounded] value of a vowel, and its absence for unrounded vowels. Cheng's proposal for the vowel geometry of Cantonese vowels is presented in (3).

(3) *Feature geometry of Cantonese vowels in Cheng (1990:112)*



The checking of the OCP violation focuses on the major articulator of the rightmost segment and operated from right to left throughout a syllable. Take three syllables for example, [po], *[pö] and *[op]. The major articulator of *o* is dorsal, that of *ö* is labial, and the articulator of *p* is labial. When the OCP checks from right to left, *po* passes because the checking is from *dorsal* to *labial* and finds no adjacent identical articulators. **pö* is ruled out because the checking is from *labia*l to *labial* and the labial co-occurrence violates the OCP. **op* is rejected because the OCP checkes both major and minor articulators of the lefthand segment. Since *o* has the *labial* articulator, its co-occurrence with the labial *p* militates against the OCP and is prohibited.

Previous works on Chinese phonotactics shed light on my study of Xuzhou Mandarin in two aspects. First, the phonotactic constraints in Chinese dialects can exist between any segments in a syllable, regardless of their sequential arrangement. This is related to the phonological domains within a syllable, and concerns the topic of syllable constituency. Second, interactions of articulatory features are main forces that work on co-occurrences or non-cooccurrences. This insight helps with the explanation for Xuzhou phonotactics within a theoretical model of constraint interactions.

However, both the syllable structure building rule and the feature geometry of vowels have their weakness. They are language-particular implementations and lack of universal implications. On the contrary, Optimality Theory can account for phonotactics with a set of universal constraints. Take the labial co-occurrence restriction for example. In Xuzhou, bilabial consonants do not co-occur with the front rounded vowel [y] but they can co-occur with the back rounded vowel [u]. Explanations can be made in different theoretical models.

One is to apply the syllable building rule. The [+rounded] feature of /u/ is initially unspecified and thus it does not have the [Lab] articulator. Its co-occurrence with labial consonants does not bring two adjacent identical features. Hence OCP is not violated. The redundancy rule assigns [+rounded] to it after OCP's checking. In

regard to /y/, its [+rounded] feature is specified underlyingly. The co-occurrence with labial consonants would produce two adjacent [Lab] features which violates OCP. Thus the syllables are prohibited.

A second way is to study the feature geometry of Xuzhou vowels and propose that [Lab] is the major articulator of /y/ but the minor articulator of /u/. OCP checks from the major articulator of the rightmost segment. Therefore, OCP identifies [Lab] of /y/ and its co-occurrence with an adjacent [Lab] feature. The syllables are ruled out due to the violation of OCP. But OCP's checking ignores [Lab] of /u/ because it is minor, and only finds one [Lab] feature carried by the consonants. Hence the syllables are acceptable.

The third explanation is offered by OT. It is not accidental to observe the same co-occurrence restriction in Xuzhou and Cantonese. Cross-linguistic evidence shows that back rounded vowels are less marked than front rounded vowels. That is to say, /u/ is less marked than /y/. In language typology, if a language has a front rounded vowel, it also has a back rounded vowel (Maddieson 1984). Within the framework of OT, the faithfulness constraints MAX-*u*-IO and MAX-*y*-IO require the preservations of inputs *u* and *y* respectively. The difference in markedness can be formulated by the universal hierarchy MAX-*u*-IO >> MAX-*y*-IO. The labial co-occurrence restriction is operated by the co-occurrence constraint *LAB LAB. The ranking MAX-*u*-IO >> *LAB LAB >> MAX-*y*-IO is able to account for the presence of [pu] and the absence of *[py].

The OT analysis is superior because it represents universality of cross-linguistic observations. The universal hierarchy MAX-*u*-IO >> MAX-*y*-IO meets the study in language typology. Besides, the universal constraints can be re-ranked to *LAB LAB >> MAX-*u*-IO >> MAX-*y*-IO for legitimate syllables [pu] and [py] in Language A. They can also be re-ranked to MAX-*u*-IO >> MAX-*y*-IO >> *LAB LAB to explain illegal syllables *[pu] and *[py] in Language B. The contribution to typological discussions is not found in the other two models.

4.3 Constraint interactions in Xuzhou phonotactics

This section examines the constraints that act on non-cooccurrences or restricted co-occurrences of segments within a Xuzhou syllable. Logical possibilities to avoid constraint violations are provided and discussed. The constraint hierarchies that explain the phonotactic patterns are proposed.

4.3.1 Co-occurrence restriction on height

In Xuzhou, high vocoids can not co-occur within a syllable. Vocoids include vowels and glides. I have proposed in Chapter 2 that both glides and vowels in Xuzhou speech are allophones of underlying vowels. Co-occurrences of high vowels are presented in (4). UR is the short form for 'underlying representation' and SR is short for 'surface representation'.

(4) *Co-occurrences of high vowels*

UR	SR
/iu/	*[iw] *[ju]
/iy/	*[jy]
/ui/	*[wi]
/uy/	*[wy]
/yu/	*[yw]
/yi/	*[ɥi]
/yu/	*[ɥu]

(4) tells that two identical high features can not co-occur adjacently. Within the framework of OT, prohibition of adjacent identical elements can be implemented by co-occurrence constraints. They are context-sensitive markedness constraints which require the output forms meet certain criterion for structural well-formedness. The constraint in (5) offers an account for non-cooccurrences of high vocoids.

(5) *[+high] [+high] $_{\sigma}$
'No co-occurrence of adjacent high vowels/glides within a syllable.'

Another co-occurrence restriction on height is between low and high vocoids within rhymes. Specifically, the vowel /ɔ/ in the underlying form /ɔu/ becomes the mid vowel [o] in the surface form. The constraint in (6) rules out *[ɔw].

(6) *[+low] [+high] $_{\text{RHYME}}$
'Low and high vowels/glides do not co-occur within rhymes.'

The treatment of ɔ as a low vowel needs to be explained. In phonology, the categorization of a segment takes two factors into consideration. One is the substantive properties of the segment. The other is the phonological contrast between/among segments. First, the segment ɔ is phonetically described as a mid-low back rounded vowel. Grouping it with low vowels does not go against its height property. Second, Xuzhou has a three-way distinction of height. Two features [high] and [low] are adequate to show vowel contrasts. The [+low] ɔ is differentiated from the [-low, -high] *o* which in turn differs from the [+high] *u*. The phonetic detail of '*mid-*' does not affect phonological categorization. Third, this treatment will not cause trouble to the distinction of low vowels. There are two low back vowels: ɔ and *a*. They have different values of roundedness. With the above reasons, the back rounded vowel ɔ is treated as [+low] in Xuzhou.

There are several ways to avoid potential violations of the co-occurrence constraint. First, the low segment is raised. Second, the high segment is lowered. Third, a mid vowel is inserted between them. Fourth, the low segment is deleted. Fifth, the high segment is deleted.

All the above operations would violate FAITHFULNESS constraints, which require that outputs preserve the properties of inputs. An inserted non-high segment does not have the corresponding input, which violates the constraint family of segment correspondence, DEP-IO. A deleted segment does not realize the input, which violates the constraint family of segmental preservation, MAX-IO. The segment whose feature is changed violates the constraint family of featural identity, IDENT-IO. The specific constraint to preserve the place feature content is IDENT-IO(place). The constraints are listed in (7–10).

(7) DEP-IO (Kager 1999:75)
'Output segments must have input correspondents.'

(8) MAX-IO (Kager 1999:55)
'Input segments must have output correspondents.'

(9) IDENT-IO (Kager 1999:55)
'Correspondents in input and output have identical feature content.'

(10) IDENT-IO(place) (Kager 1999:132)
'Correspondents in input and output have identical place features.'

The legal [ow] shows that the first solution works in Xuzhou phonology. The analysis is illustrated in the tableau (11). The solid line denotes 'domination'. It means the constraint on the left-hand dominates the constraint on the right-hand. The index '☞' points to the optimal output, and the violation in grey cells does not contribute to select the winner.

(11)

Input: /ɔu/	*[+lo][+hi]$_{RHYME}$	MAX-IO	DEP-IO	IDENT(+hi)	IDENT(+lo)
a. ɔw	*!				
b. u		*!			
c. ɔ		*!			
d. ɔəw			*!		
e. ɔo				*!	
f. ☞ ow					*

No change happens to candidate (a.). The co-occurrence is excluded because it violates *[+lo][+hi]$_{RHYME}$. Candidates (b.-c.) fail because they violate MAX-IO which disallows deletion. Candidate (d.) is ruled out because it violates DEP-IO which prohibits insertion. Candidate (e.) fails because it violates IDENT(+hi) which requires preservation of the feature [+high]. Yet candidate (f.) is selected even though it violates IDENT(+lo). This is because IDENT(+lo) is lower-ranked. The violation is not fatal. The constraint hierarchy is summarized in (12) where '>>' denotes 'crucial ranking'.

(12) *[+lo][+hi]$_{RHYME}$, DEP-IO, MAX-IO, IDENT(+hi) >> IDENT(+lo)

4.3.2 Co-occurrence restriction on roundedness

In Xuzhou, Nucleus and Coda must have the same value of roundedness whereas Medial and Nucleus can not both be rounded. The co-occurrence data are shown in (13).

(13) *Co-occurrences of rounded vowels*

	UR	SR
a. Nuc+Cod	/ɔu/	[ow]
	/au/	*[aw]
	/ɛu/	*[ɛw]
b. Med+Nuc	/iɛn/	[jæ̃]
	/ua/	[wa]
	/uɔ/	*[wɔ] *[wo]
	/yɔ/	*[ɥɔ]

(13a.) shows that segments in rhymes share the same roundedness feature, either [+rounded] or [-rounded]. This is a case of harmony, a phonological state where segments in a certain domain share a particular feature (Kenstowicz 1994:347). (13b.) shows that segments ahead of Coda can be both [-rounded] or have different values of roundedness, but two rounded vocoids are banned.

Harmony is treated as feature agreement within a phonological or morphological domain. Cole and Kisseberth (1994) propose the Optimal Domains Theory (ODT). The primary idea is that features are parsed in domains, and there are no assumptions on the underlying specification or underspecification of elements in the domains.

Lin (2000) studies the vowel harmony in Yangu dialect spoken in *Shandong* province of China. In this language, mid vowel nuclei undergo rounding or backing processes regressively, and undergo the fronting process progressively. She proposes two subsyllabic domains. One is the *rhyme* domain where the rounding or backing processes happen. It includes Nucleus and Coda. The other is the *minimal syllable* domain where the fronting process happens. It includes Onset and Nucleus. (Lin 2000:147).

Following Lin (2000), I assume the subsyllabic domains exist in Xuzhou phonology. The *rhyme* domain including Nucleus and Coda is evidenced by the height co-occurrence in (11) and roundedness co-occurrences in (13a.). The *minimal syllable* domain including Onset, Medial and Nucleus is evidenced by roundedness co-occurrences in (13b.).

Harmony is modeled as alignment constraints in OT. McCarthy and Prince (1993) propose the Generalized Alignment Constraint in (14). 'Cat' is the short form for 'category'. It ranges over grammatical and phonological categories. 'Edge' concerns the domain of alignment. It can be the left/right edge or both. The definition is read as 'for any Cat_1, there is a Cat_2 whose $Edge_2$ is the same with the $Edge_1$ of Cat_1'.

(14) *Generalized alignment* (McCarthy and Smolensky 1993:2)

Align (Cat_1, $Edge_1$; Cat_2, $Edge_2$) $=_{def}$
$\forall$ Cat_1 $\exists$ Cat_2 such that $Edge_1$ of Cat_1 and $Edge_2$ of Cat_2 coincide.
Where Cat_1, $Cat_2 \in$ ProsCat $\cup$ GramCat
$Edge_1$, $Edge_2 \in$ {Right, Left}

The alignment constraint that takes effect in Xuzhou can be formulated in (15). It rules out any rhyme whose constituents have different roundedness values.

(15) ALIGN (round, edge; rhyme, edge)
'Align the roundedness feature to both edges of the rhyme.'

One more constraint shall be called on to account for the prohibition of two adjacent rounded segments in the minimal syllable domain 'σ_m'. The co-occurrence constraint in (16) is able to explain the data in (13b.).

(16) *[+round] [+round] $_{\sigma m}$
'No co-occurrence of adjacent rounded segments in σ_m.'

4.3.3 Co-occurrence restriction on backness

In Xuzhou, non-high front Nucleus does not co-occur with high back Coda. This generalization has two crucial factors. First, when there are disagreements on both height and backness, the co-occurrences are not allowed. Second, this phonotactic restriction takes effect within the rhyme domain. Data are shown in (17).

(17) *Co-occurrences of front and back segments*

	UR	SR
a. Nuc+Cod	/eŋ/	*[eŋ]
	/ɛŋ/	*[ɛŋ]
	/eu/	*[ew]
	/ɛu/	*[ɛw]
b. Nuc+Cod	/iŋ/	[iŋ]
	/yŋ/	[yŋ]
c. Med+Nuc	/iɑ/	[jɑ]
	/iɔu/	[jow]
	/uɑ/	[wɑ]

(17a.) presents the data described by the non-occurrence generalization. (17b.) is to compare with (17a.). It shows that when Nucleus and Coda have the same value of height, the rhyme can be acceptable. (17c.) demonstrates that the non-occurrence generalization does not apply in the minimal syllable domain, where two segments can differ in both height and backness.

The constraint that disfavors a non-high segment followed by a high segment within the rhyme domain is proposed in (18). And the constraint that disfavors a front segment followed by a back segment within the rhyme domain is proposed in (19).

(18) *[-high] [+high] $_{\text{RHYME}}$
'Non-high and high segments do not co-occur in rhymes.'

(19) *[-back] [+back] $_{\text{RHYME}}$
'Front and back segments do not co-occur in rhymes.'

It is the coaction of (18) and (19) that can explain the non-cooccurrences of non-high front segments and high back segments. In OT terminology, the two constraints are under *local conjunction*. The constraints C_1 and C_2 are conjoined as a single composite constraint which is violated if and only if both are violated within the domain δ (Kager 1999:392). The constraint family and the specific constraint to account for Xuzhou phonotactics are provided in (20) and (21) respectively.

(20) $[C_1 \& C_2]_\delta$ (Kager 1999:393)

(21) $[*[\text{-hi}][\text{+hi}] \& *[\text{-bk}][\text{+bk}]]_{\text{RHYME}}$
'Segments within the rhyme can not differ in both height and backness.'

All the above constraints can not account for the absence of *[ɥɑ] in Xuzhou syllables. As is proposed in Chapter 2, the high front rounded glide [ɥ] is an allophone of the vowel /y/, and the low back unrounded vowel [ɑ] is the surface form of /ɑ/. The conflicts between the two segments can be understood from an articulatory perspective. *y* and *a* differ in all the three dimensions of vowels, namely, height, backness and roundedness. The production of *[ɥɑ] causes much articulatory difficulty. Hence the phonological system bans its realization.

*[ɥɑ] is the only combination of segments that has conflicts in all three dimensions. Given this idiosyncratic property, the constraint in (23) is proposed. It is modeled after an analogous constraint in Kager (1999:260), presented in (22). The constraint in (23) is simpler than a local-conjoined constraint with three component constraints, and it is sufficient to offer an account.

(22) *ær]$_\sigma$ (Kager 1999:260)
'No *æ* before tautosyllabic *r*.'

(23) *yɑ]$_\sigma$
'No *y* before tautosyllabic *a*.'

There is another co-occurrence restriction. The front rounded vocoid does not co-occur with front oral vowels. Specifically, *[ɥɛ] and *[ɥe] are not accepted, shown in (24a.). But [ɥ] is found to co-occur with front nasal vowels [ɥæ̃] and [ɥẽ], shown in (24b.). I have proposed in Chapter 2 that these nasal vowels are realized from *central* vowels and the dental nasal. (24a.) are illegal because two front vowels co-occur. (24b.) are acceptable because the vocoids do not have the same backness value.

(24) *Co-occurrences of y and front vowels*

a.

UR	SR	UR	SR
/ye/	*[ɥe]	/ yɛ/	*[ɥɛ]

b.

UR	SR	UR	SR
/ yən/	[ɥẽ]	/ yɐn/	[ɥæ̃]

The co-occurrence constraint in (25) is at work. It prevents co-occurrences of two front vocoids. (25) would exclude legitimate words such as [tɕjɛ^{35}] 姐 ('elder sister') where the front *j* and *ɛ* co-occur. Survival of these words owes to interaction of the palatal co-occurrence constraint and the backness co-occurrence constraint, which will be discussed in section 4.3.6.

(25) *[-back] [-back] $_{\sigma}$
'No co-occurrence of adjacent front vowels/glides within a syllable.'

4.3.4 Co-occurrence restriction on labials

Co-occurrences of labial consonants and rounded vocoids are displayed in (26). (26a.) shows that labials do not co-occur with any rounded glides. (26b.) shows that labials can co-occur with the nucleus [u] but disfavor the nucleus [y]. (26c.) shows that labials can accept the rounded glide when there is a nucleus [ə].

(26) *Co-occurrences of labials and rounded vocoids*

a.

UR	SR	UR	SR
/pue/	*[pwe]	/puɑ/	*[pwɑ]
/p^{h}ue/	*[p^{h}we]	/p^{h}uɑ/	*[p^{h}wɑ]
/mue/	*[mwe]	/muɑ/	*[mwɑ]
/fue/	*[fwe]	/fuɑ/	*[fwɑ]

b.

UR	SR	UR	SR
/pu/	[pu]	/py/	*[py]
/p^{h}u/	[p^{h}u]	/p^{h}y/	*[p^{h}y]
/mu/	[mu]	/my/	*[my]
/fu/	[fu]	/fy/	*[fy]

c.

UR	SR
/pə/	[pwə]
/p^{h}ə/	[p^{h}wə]
/mə/	[mwə]
/fə/	[fwə]

Rounded vocoids are labial segments. The absence of (26a.) in Xuzhou can be attributed to the labial co-occurrence restriction. The phonotactic constraint states that two adjacent labials can not co-occur. It takes effect within the minimal syllable domain, but does not work within the rhyme domain. As is described in section 4.3.2, segments in rhymes must agree in roundedness. Thus a more general constraint is proposed in (27).

(27) *LAB LAB $_{\sigma m}$
'No co-occurrence of adjacent labial segments in σ_m.'

(26b.) violates (27). The difference between (26a.) and (26b.) lies in the role of rounded vocoids in a syllable. When /u/ is realized as the nucleus [u], the syllable is accepted. But when it becomes the glide [w], the syllable is banned. This is because Nucleus is the syllable peak, and ideally input V's need to be parsed as peaks rather than margins (Prince and Smolensky 2004:150). Therefore, the nuclear position is less marked than the medial position regarding syllabification of a vowel. The faithfulness constraint in (29) can account for the co-occurrences of labial onsets with the nuclear [u]. It is modeled after the more general constraint in (28).

(28) MAX-V-IO (Kager 1999:178)

(29) MAX-*u*-IO/NUC
'The input /u/ has an output correspondent at the nuclear position.'

(26b.) also shows a comparison between the back rounded vowel /u/ and the front rounded vowel /y/. In language typology, if a language has a front rounded vowel, it also has a back rounded vowel (Maddieson 1984; Flemming 2003:2). A back rounded vowel is less marked than a front rounded vowel. Different phonotactic behaviors of /u/ and /y/ are subject to markedness of segments. Since /u/ is less marked, it is less restrictive to obey the labial co-occurrence constraint. This relation can be expressed by the constraint hierarchy in (30).

(30) MAX-*u*-IO/NUC >> *LAB LAB $_{\sigma m}$ >> MAX-*y*-IO/NUC

In (26c.), two labial segments co-occur within a syllable and the nucleus is not [u]. The nucleus is the mid central vowel [ə]. The production of [ə] requires less articulatory effort than other vowels, and this vowel is perceptually less salient than other vowels. The monophthongal rime [-ə] can not constitute stressed syllables. Stressed syllables are heavy and unstressed syllables are light. The notion *mora* 'μ' has been invoked to represent 'weight-bearing unit'. A heavy syllable consists of two moras and a light syllable of one (Hyman 2003:10). The constraint in (31) prohibits light syllables.

(31) $*\sigma_{\mu}$ (Kager 1999:283)
'No light syllable.'

In Xuzhou, I define those syllables whose rime is a short vowel as monomoraic syllables. They can only appear in unstressed words. I assume that front and back vowels can be lengthened in open syllables. The underlying /CV/ becomes [CV:] in surface. The notation ':' denotes 'long'. A syllable such as [tɛ] shall be [tɛ:] in narrow transcription. Syllables with long vowels are heavy and they satisfy the constraint $*\sigma_{\mu}$. On the contrary, central vowels can not be lengthened. Poverty of long central vowels is cross-linguistically grounded. The lack of long [ɨ] is found in Yakima Sahaptin and the lack of long [ə] is found in Yiddish. It can be explained by the inherent weakness and low sonority of central vowels (Topintzi 2006: 242).

When the pre-nuclear glide [w] appears in the monophthongal rime [-ə], the light syllable becomes heavy and the violation of $*\sigma_{\mu}$ is avoided. Yet the labial-cooccurrence constraint is sacrificed. The constraint hierarchy in (32) can account for legitimate syllables in (26c.).

(32) $*\sigma_{\mu}$ >> *LAB LAB $_{\sigma m}$, DEP-IO

The following tableau analyzes selection of [pwə]. Candidate (a.) makes no change from the input. It violates the higher-ranked constraint $*\sigma_{\mu}$. Candidate (b) has an inserted labial-velar segment. It violates both *LAB LAB $_{\sigma m}$ and DEP-IO constraints. The violations are not fatal because these two constraints are lower-ranked. Thus candidate (b.) is selected.

(33)

Input: /pə/	$*\sigma_{\mu}$	*LAB LAB $_{\sigma m}$	DEP-IO
a. pə	*!		
b. ☞ pwə		*	*

There is a special restriction on labial fricatives. While labial stops [p, p^h, m] can co-occur with high front vowels or glides, labial fricatives never co-occur with high front glides. Stops and fricatives differ in continuation of articulation. The constraint in (34) prevents a continuant labial segment from co-occurring with high vocoids.

(34) *LAB$_{[+cont]}$-[+hi]
'No labial fricative before a high vowel/glide.'

Labial fricatives can co-occur with high front vowels but not glides. Two sets of data are provided in (35) for comparison.

(35) *Co-occurrences of labial fricatives and high front vocoids*

a.

UR	SR	UR	SR
/fiɔ/	*[fjɔ]	/fiə/	*[fjə]
/uiɔ/	*[vjɔ]	/uiə/	*[vjə]

b.

UR	SR
/fi/	[fi]
/ui/	[vi]

The legitimate syllables in (35b.) can survive from violation of (34) because the underlying high vowel is parsed into Nucleus. For vowels, Nucleus is a less marked syllable position than Medial. The requirement to preserve a nuclear /i/ can be formulated in (36) and the general requirement to preserve the vowel /i/ is in (37).

(36) MAX-*i*-IO/NUC
'The input /i/ has an output correspondent at the nuclear position.'

(37) MAX-*i*-IO
'The input /i/ has an output correspondent.'

The constraint hierarchy in (38) can account for co-occurrences of labial fricatives with the nuclear [i] but not with the medial [j].

(38) MAX-*i*-IO/NUC >> *LAB$_{[+cont]}$-[+hi] >> MAX-*i*-IO

4.3.5 Co-occurrence restriction on coronals

Coronal continuants can not co-occur with high front vocoids. The data are shown in (39). A markedness constraint that prevents their co-occurrences is proposed in (40), where 'I' stands for high front vowels or glides.

(39) *Co-occurrences of coronal continuants and high vocoids.*

UR	SR
/tsi/	*[tsi]
/ts^{h}i/	*[ts^{h}i]
/si/	*[si]
/tʂi/	*[tʂi]
/tʂ^{h}i/	*[tʂ^{h}i]
/ʂi/	*[ʂi]
/ɻi/	*[ɻi]

UR	SR
/tsiə/	*[tsjə]
/ts^{h}iə/	*[ts^{h}jə]
/siə/	*[sjə]
/tʂiə/	*[tʂjə]
/tʂ^{h}iə/	*[tʂ^{h}jə]
/ʂiə/	*[ʂjə]
/ɻiə/	*[ɻjə]

UR	SR
/tsy/	*[tsy]
/ts^{h}y/	*[ts^{h}y]
/sy/	*[sy]
/tʂy/	*[tʂy]
/tʂ^{h}y/	*[tʂ^{h}y]
/ʂy/	*[ʂy]
/ɻy/	*[ɻy]

UR	SR
/tsyə/	*[tsɥə]
/ts^{h}yə/	*[ts^{h}ɥə]
/syə/	*[sɥə]
/tʂyə/	*[tʂɥə]
/tʂ^{h}yə/	*[tʂ^{h}ɥə]
/ʂyə/	*[ʂɥə]
/ɻyə/	*[ɻɥə]

(40) *COR$_{[+cont]}$-I
'No coronal continuant before a high front vowel/glide.'

Syllabic approximants can only co-occur with coronal continuants within a syllable. Xuzhou has two syllabic approximants [ɹ̩, ɻ̩]. They are prolongation of preceding consonants. The two segments do not exist underlyingly. The co-occurrence data are provided in (41).

(41) *Co-occurrences of syllabic approximants and coronal continuants*

UR	SR
/ts/	[tsɹ̩]
/ts^{h}/	[ts^{h}ɹ̩]
/s/	[sɹ̩]
/tʂ/	[tʂɻ̩]
/tʂ^{h}/	[tʂ^{h}ɻ̩]
/ʂ/	[ʂɻ̩]
/ɻ/	[ɻɻ̩]

A single consonant onset can not form an entire syllable under the effect of the markedness constraint in (42).

(42) NUC (Prince and Smolensky 2004:108)
'Syllables must have nuclei.'

The underlying consonants are not parsed into the nuclear position due to its low sonority. In Xuzhou, coronal stridents are prolonged and syllabic approximants are generated consequently. Approximants are perceptually more prominent than fricatives and affricates. (43) presents the universal sonority scale of sounds. Approximants are the subtype of liquids.

(43) *Sonority Scale* (Prince and Smolensky 2004:15)

|low V| > |high V| > |liquid| > |nasal| > |voiced fricative| > |voiceless fricative| >|voiced stop| > |voiceless stop|

Studies of syllable structures suggest that a more sonorous sound is more harmonious at the syllable peak and a less sonorous sound is more harmonious at syllable margins (Prince and Smolensky 2004:159-177). The markedness constraint in (44) is at work to prohibit obstruents from realizing at the nuclear position.

(44) *$\text{NUC}_{[-son]}$
'No obstruent nuclei.'

The nuclear position need to be filled. Inserting a segment is a possible solution, but it violates the faithfulness constraint DEP-IO. Extending the input segment to the nuclear position is another means, but it violates the faithfulness constraint INTEGRITY in (45). This constraint goes against multiple output correspondents, yet it avoids the violation of DEP-IO which would be incurred by an epenthetic segment (Smith 2002:98).

(45) INTEGRITY (McCarthy and Prince 1995:124)
'Input segments do not have multiple output correspondents.'

The dental lateral and nasal have the same place of articulation with /ts, ts^h, s/ and they are sonorants. They do not follow a tautosyllabic dental strident because the former do not share the same [continuant] feature with the latter. The faithfulness constraint in (46) preserves this manner of articulation.

(46) IDENT(+cont)
'The input and output correspondents have identical [+continuant] feature.'

The emergence of syllabic approximants can be analyzed in the tableau (47).

(47)

Input:/$s_{1,2}$/	NUC	DEP-IO	*NUC$_{[-son]}$	IDENT(+cont)	INTEGRITY
a. s	*!				
b. se		*!			
c. $\underset{\cdot}{s}$			*!		
d. $s_1\underset{\cdot}{s}_2$			*!		*
e. $s_1\underset{\cdot}{l}_2$				*!	*
f. ☞ $s_1\underset{\cdot}{I}_2$					*

Candidate (a.) makes no change from the input. It violates the markedness constraint NUC. Candidate (b.) has an inserted vowel which violates the faithfulness constraint DEP-IO. Candidate (c.) parses the obstruent into the nucleus. It violates *NUC$_{[-son]}$. Candidates (d.-f.) have syllabic consonants that share the same place of articulation with the input segment. They correspond to the input and this relation violates INTEGRITY. Candidate (d.) has the obstruent nucleus and violates *NUC$_{[-son]}$. The nucleus of candidates (e.) becomes [-continuant]. This goes against IDENT(+cont). Candidate (f.) is the winner. It is selected because the constraint INTEGRITY is lowered-ranked and the violation is tolerable. The constraint hierarchy is summarized in (48).

(48) NUC, DEP-IO, *NUC$_{[-son]}$, IDENT(+cont) >> INTEGRITY

Retroflex consonants do not co-occur with front oral vowels, but they can appear before nasal vowels. The data are shown in (49).

(49) *Co-occurrences of retroflex and front vowels*

a.

UR	SR	UR	SR
/tʂe/	*[tʂe]	/tʂɛ/	*[tʂɛ]
/tʂʰe/	*[tʂʰe]	/tʂʰɛ/	*[tʂʰɛ]
/ʂe/	*[ʂe]	/ʂɛ/	*[ʂɛ]
/ɻe/	*[ɻe]	/ɻɛ/	*[ɻɛ]

b.

UR	SR	UR	SR
/tʂən/	[tʂə̃]	/tʂɐn/	[tʂæ̃]
/tʂʰən/	[tʂʰə̃]	/tʂʰɐn/	[tʂʰæ̃]
/ʂən/	[ʂə̃]	/ʂɐn/	[ʂæ̃]
/ɻən/	[ɻə̃]	/ɻɐn/	[ɻæ̃]

The difference between the two data sets rests in the backness value of the nuclear vowels. The underlying vowels in (49a.) are front and those in (49b.) are central. Non-cooccurrences of retroflex consonants and front vowels are due to articulatory difficulty. The articulation of a retroflex segment raises the tongue tip and curls it backward. This movement physically causes retraction of the tongue body. But the articulation of a front vowel/glide involves fronting of the tongue. The opposite directions of the tongue movement makes it hard to produce syllables like *[tʂe] or *[ɻɛ].

The markedness constraint that prohibits co-occurrences between retroflex consonants and front vowels is proposed in (50).

(50) *Retroflex-$V_{[-bk]}$
'No retroflex before a front vowel/glide.'

4.3.6 Co-occurrence restriction on palatals and velars

Palatals only co-occur with high front vocoids whereas velars never co-occur with high front vocoids. I have argued in Chapter 2 that palatals and velars are variants of the velar phonemes. The co-occurrence data are provided in (51).

(51) *Co-occurrences of velars and high front vocoids*

a.

UR	SR	
/ki/	[tɕi]	*[ki]
/k^hi/	[tɕ^{h}i]	*[k^hi]
/xi/	[ɕi]	*[xi]

UR	SR	
/kiɛ/	[tɕjɛ]	*[kjɛ]
/k^hiɛ/	[tɕ^{h}jɛ]	*[k^hjɛ]
/xiɛ/	[ɕjɛ]	*[xjɛ]

b.

UR	SR	
/ke/	[ke]	*[tɕe]
/k^he/	[k^he]	*[tɕ^{h}e]
/xe/	[xe]	*[ɕe]

UR	SR	
/ku/	[ku]	*[tɕu]
/k^hu/	[k^hu]	*[tɕ^{h}u]
/xu/	[xu]	*[ɕu]

(51a.) shows that when a velar consonant precedes a high front vowel within the same syllable, it can not be realized at the surface form. The markedness constraint in (52) is at work, where 'I' stands for high front vowels/glides.

(52) *VELAR-I
'No velar before a high front vowel/glide.'

There are several ways to avoid the constraint violation. First, either of the input segments changes the place features. Second, a non-high vowel is inserted between them. Third, one of the segments is deleted. The analysis is illustrated below.

(53)

Input: /xi/	*VELAR-I	IDENT-IO/NUC	DEP-IO	MAX-IO	IDENT-IO/ONS
a. xi	*!				
b. xe		*!			
c. xu		*!			
d. xei			*!		
e. x				*!	
f. i				*!	
g. ☞ ɕi					*

Candidate (a.) has no difference from the input. It violates the markedness constraint *VELAR-I. Changing the place feature of the nuclear vowel can generate candidates (b.) and (c.). The vowel in (b.) is lowered and the vowel in (c.) is retracted. Both violate the constraint (54) that preserves the feature of nuclear vowels.

(54) IDENT-IO/NUC
'Correspondents in input and output at Nucleus have identical feature content.'

Insertion of a segment between the two input segments gives rise to candidate (d.). It violates the faithfulness constraint DEP-IO. Deletion of either segment produces candidates (e.-f.). Both violate the faithfulness constraint MAX-IO. Changing the place feature of the onset consonant produces candidate (g.). It violates the faithfulness constraint in (55) which preserves the feature of onsets.

(55) IDENT-IO/ONS
'Correspondents in input and output at Onset have identical feature content.'

Selection of the optimal candidate goes to (g.). It indicates that the violated constraint IDENT-IO/ONS is lower-ranked than others and can be sacrificed. The constraint hierarchy is summarized in (56).

(56) *VELAR-I, IDENT-IO/NUC, DEP-IO, MAX-IO >> IDENT-IO/ONS

Palatal glides do not occur between non-palatal onsets and the low front oral vowel. The data are shown in (57).

(57) *Co-occurrences of i and ɛ*

	UR	SR
a.	/piɛ/	*[pjɛ]
	/pʰiɛ/	*[pʰjɛ]
	/miɛ/	*[mjɛ]
	/fiɛ/	*[fjɛ]
b.	/tiɛ/	*[tjɛ]
	/tʰiɛ/	*[tʰjɛ]
	/niɛ/	*[njɛ]
	/liɛ/	*[ljɛ]
c.	/tsiɛ/	*[tsjɛ]
	/tsʰiɛ/	*[tsʰjɛ]
	/siɛ/	*[sjɛ]
d.	/ʈʂiɛ/	*[ʈʂjɛ]
	/ʈʂʰiɛ/	*[ʈʂʰjɛ]
	/ʂiɛ/	*[ʂjɛ]
	/ɻiɛ/	*[ɻjɛ]
e.	/kiɛ/	[tɕjɛ]
	/kʰiɛ/	[tɕʰjɛ]
	/xiɛ/	[ɕjɛ]
f.	/iɛ/	[jɛ]

The onset consonants in (57a.-d.) are not palatal. They can not co-occur with the rime [jɛ]. The legitimate syllable in (57f.) has zero onset. The glide [j] fills in the onset position to satisfy the markedness constraint ONSET in (58).

(58) ONSET (Kager 1999:93)
'Syllable must have onsets.'

The comparison between (57a.-d.) and (57f.) tells that /i/ and /ɛ/ within the rime domain can not co-occur. Since both are front vowels, they have the same feature [-back]. The co-occurrence constraint in (59) plays a role.

(59) *[-back] [-back] $_{RIME}$
'No co-occurrence of adjacent front vowels/glides within the rime.'

In (57e.), the glide [j] does not occupy the onset position. It is Medial. Its legal appearance before [ɛ] is due to the markedness constraint PALATAL-I which requires palatals shall precede high front vowels or glides. The constraint is shown in (60), where 'I' stands for high front vowels/glides.

(60) PALATAL-I
'A palatal segment must precede a high front vowel/glide.'

The analysis of a legitimate syllable is illustrated in the tableau (61).

(61)

Input: /kiɛ/	*VELAR-I	PALATAL-I	*[-bk][-bk]$_{RIME}$	IDENT-IO/ONS
a. kjɛ	*!		*	
b. tɕɛ		*!		*
c. ☞ tɕjɛ			*	*

Candidate (a.) makes no change from the input. It violates *VELAR-I which prohibits a velar before a high front vocoid. Candidate (b.) changes the velar onset to palatal. It satisfies *VELAR-I. The high vowel is deleted from (b.). It satisfies *[-bk][-bk]$_{RIME}$ but violates PALATAL-I. Candidate (c.) changes the place feature of the onset. It incurs violation of *[-bk][-bk]$_{RIME}$. Both (b.) and (c.) violate the faithfulness constraint IDENT-IO/ONS. Candidate (c.) is selected, indicating that the constraints violated by (c.) shall be lowered-ranked than others. The constraint hierarchy is summarized in (62).

(62) *VELAR-I, PALATAL-I >> *[-bk][-bk]$_{RIME}$, IDENT-IO/ONS

Another co-occurrence restriction is found between non-anterior consonants and the monophtongal rime [-ə]. Only retroflex and velar consonants are reported to precede this rime (Su and Lü 1996). I assume that the underlying /ə/ becomes the back vowel [ɤ] after retroflexes or velars.

This consideration has an articulatory basis. In the retroflex production, the tongue tip is raised upward and curled backward towards the post-alveolar area. In the velar production, the tongue back is raised towards the velum. Both can

physically retract the immediately following mid central vowel from the neutral position to back. On the contrary, anterior consonants can not trigger the retraction because it lacks phonetic motivation.

Back vowels can be lengthened which will increase the syllable weight, whereas central vowels can not due to its intrinsic weakness or low sonority. I treat open syllables with the rime [-ə] as mono-moraic and open syllables with the rime [-ɤ] as bi-moraic. The bi-moraic syllable is heavy and can form a stressed word. The analysis is shown in the tableau (63).

(63)

Input: /kə/	$*\sigma_{\mu}$	IDENT(bk)
a. kə	*!	
b. ☞ kɤ		*

Candidate (a.) remains unchanged and it violates the markedness constraint $*\sigma_{\mu}$ which disallows a light syllable. Candidate (b.) violates the faithfulness constraint IDENT(bk) which requires backness preservation. (b.) wins over (a.), indicating that violation of the markedness constraint is fatal. Thus $*\sigma_{\mu}$ overrides IDENT(bk). The hierarchy is summarized in (64).

(64) $*\sigma_{\mu}$ >> IDENT(bk)

4.4 Summary

In this chapter, I have provided an optimality-theoretic account for Xuzhou phonotactics. I have shown that co-occurrence generalizations drawn in Chapter 3 can be explained by the interactions of universal and violable constraints. Non-cooccurrences result from the undominated markedness constraints. Alternating forms are realized under the competition of ranked constraints.

The constraints in (65) operate in Xuzhou phonotactics within a syllable. The crucial rankings are summarized in (66) and other constraints are undominated.

(65) *Constraints in Xuzhou phonotactics*

	Markedness constraints
1.	*[+hi][+hi]$_{\sigma}$,
2.	*[+rnd][+rnd]$_{\sigma m}$
3.	*[+lo][+hi]$_{RHYME}$
4.	*[-hi][+hi] $_{RHYME}$
5.	*[-bk][+bk] $_{RHYME}$
6.	[*[-hi][+hi]&*[-bk][+bk]] $_{RHYME}$
7.	*yɑ]$_{\sigma}$
8.	*LAB LAB $_{\sigma m}$
9.	*LAB$_{[+cont]}$-[+hi]
10.	*COR$_{[+cont]}$-I
11.	*Retroflex-V$_{[-bk]}$
12.	*VELAR-I
13.	PALATAL-I
14.	*[-bk][-bk]$_{RIME}$
15.	ONSET
16.	NUC
17.	*NUC$_{[-son]}$
18.	*σ_{μ}
	Faithfulness constraints
19.	IDENT-IO
20.	IDENT-IO(place)
21.	IDENT(+hi)
22.	IDENT(+lo)
23.	IDENT(bk)
24.	IDENT(+cont)
25.	IDENT-IO/NUC

26.	IDENT-IO/ONS
27.	MAX-IO
28.	MAX-*u*-IO/NUC
29.	MAX-*y*-IO/NUC
30.	MAX-*i*-IO/NUC
31.	MAX-*i*-IO
32.	DEP-IO
33.	INTEGRITY
	Alignment constraint
34.	ALIGN(round, edge; rhyme, edge)

(66) *Crucial constraint rankings in Xuzhou phonotactics*

1. *[+lo][+hi]$_{\text{RHYME}}$, DEP-IO, MAX-IO, IDENT(+hi) >> IDENT(+lo)

2. MAX-*u*-IO/NUC >> *LAB LAB$_{\sigma m}$ >> MAX-*y*-IO/NUC

3. *σ_{μ} >> *LAB LAB$_{\sigma m}$, DEP-IO

4. MAX-*i*-IO/NUC >> *LAB$_{[+cont]}$-[+hi] >> MAX-*i*-IO

5. NUC, DEP-IO, *NUC$_{[-son]}$, IDENT(+cont) >> INTEGRITY

6. *VELAR-I, IDENT-IO/NUC, DEP-IO, MAX-IO >> IDENT-IO/ONS

7. *VELAR-I, PALATAL-I >> *[-bk][-bk]$_{\text{RIME}}$, IDENT-IO/ONS

8. *σ_{μ} >> IDENT(bk)

Chapter 5 Morphophonemic Alternations under ɻ-suffixation and OT Account

ɻ-suffixation is a morphophonemic process in Xuzhou dialect. This chapter is going to examine segmental changes under ɻ-suffixation. It begins with the description of basic facts and draws generalizations from them. Previous studies on diminutive suffixation in Chinese dialects are then introduced and discussed. An optimality-theoretic analysis is built up as an advanced approach to explain the observations of ɻ-suffixation in Xuzhou. The chapter is closed with a summary of crucial constraint rankings.

5.1 Phonological representations of the suffix

Many Chinese dialects in the *Mandarin* family have the diminutive suffix *Er* (儿). The *Er*-suffixation in Beijing Mandarin has been well-studied. There are two assumptions on the phonological representation of the suffix. Lin (1989:112) and Zhang (2000:427) assume it is a retroflex approximant, and Wang (1993:180-185) treats it as a single [posterior] feature under the coronal articulator.

I propose that the diminutive suffix in Xuzhou is an independent segment /-ɚ/ rather than a feature. It has both the vocalic feature and the rhotic feature. When the rimes /iŋ, yŋ, uŋ, ɑŋ/ in stems are suffixed, they become [ĩɻ, ỹɻ, ũɻ, ɑ̃ɻ] in suffixed words. [-ɻ] is the realization of the suffix with the vocalic feature missing. If the suffix is a feature, it shall be attached to the coda and incompatible features in the coda are deleted. The results shall be *[iŋ˞, yŋ˞, uŋ˞, ɑŋ˞] (‘ ˞ ’ is the diacritic for the rhotic feature) which are not found in Xuzhou. If the suffix is a segment, it replaces the coda directly and the nasal feature is preserved under certain faithfulness constraint and passed on to the nucleus.

According to the description in Li (1983), the surface form can be a retroflex segment or just the rhotic “color”. I will use [ɻ] for the former and the rhotic diacritic ‘ ˞ ’ for the latter.

5.2 Basic facts of ɻ-suffixation in Xuzhou

Xuzhou has 37 rimes in unsuffixed mono-syllabic words. They are listed in (1). Rimes in (1a.–b.) can co-occur with onset consonants but the rime in (1c.) can not. Nuclei in in (1a.) are laminal and those in (1b.–c.) are apical. (1a.) is further divided into four groups according to the rime-initial segments. Base words with the rimes in (1a.–b.) can be suffixed with the diminutive marker /-ɚ/.

(1) *Xuzhou rimes without affixation*

a.

non-high V			e	ẽ	ɛ	æ̃	ə	əŋ	ɑ	ɑŋ	ow	ɔ
[i] or [j]	i	iŋ		jẽ	jɛ	jæ̃	jə		jɑ	jɑŋ	jow	jɔ
[u] or [w]	u	uŋ	we	wẽ	wɛ	wæ̃	wə		wɑ	wɑŋ		
[y] or [ɥ]	y	yŋ		ɥẽ		ɥæ̃	ɥə					

b.

apical nuclei	ɿ ʅ

c.

rhotic nucleus	ɚ

The following data are drawn from literatures. (2–4) and (7–11) are from Li (1983), and (5–6) are from Su and Lü (1996). One modification is made to Li's data. Since Li uses [ɜ] and Su and Lü use [ɐ] to denote the low central unrounded vowel, I will use [ɐ] for the segment in order to be consistent with the data in previous chapters.

(2)

[pʰu^{51}] + /ɚ/	→	[pʰuɻ^{51}]	铺儿	'small shop'
[mɔ^{51}] + /ɚ/	→	[mɔɻ^{51}]	帽儿	'little cap'
[mjɔ^{55}] + /ɚ/	→	[mjɔɻ^{55}]	苗儿	'seedling'
[mɑ^{35}] + /ɚ/	→	[mɑɻ^{35}]	码儿	'small pieces'
[jɑ^{55}] + /ɚ/	→	[jɑɻ^{55}]	芽儿	'sprout'
[xwɑ^{213}] + /ɚ/	→	[xwɑɻ^{213}]	花儿	'lovely flower'

The base words in (2) have open syllables whose nuclei are back vowels. The suffix is attached to the syllable directly. ɻ-suffixation does not cause any sound change to base words.

(3)	[kə^{51}] + /ər/	→	[kɤɻ^{51}]	个儿	'body height'
	[t^{h}jə^{55}] + /ər/	→	[t^{h}jɤɻ^{55}]	蝶儿	'butterfly'
	[xwə^{35}] + /ər/	→	[xwɤɻ^{35}]	火儿	'angry'
	[tɕɥə^{213}] + /ər/	→	[tɕɥɤɻ^{213}]	角儿	'actor'

The base words in (3) have open syllables whose nucleus is the mid central vowel [ə]. The suffix is attached to the syllable, and /ə/ becomes the back vowel [ɤ].

(4)	[pe^{51}] + /ər/	→	[pəɻ^{51}]	辈儿	'generation'
	[kwe^{51}] + /ər/	→	[kwəɻ^{51}]	柜儿	'small cabinet'

The base words in (4) have open syllables whose nucleus is the front mid oral vowel [e]. The suffix is attached to the syllable, and /e/ becomes the mid central vowel [ə].

(5)	[pẽ^{35}] + /ər/	→	[pəɻ^{35}]	本儿	'notebook'
	[tɕjẽ^{213}] + /ər/	→	[tɕjəɻ^{213}]	今儿	'today'
	[t^{h}wẽ^{55}] + /ər/	→	[t^{h}wəɻ^{55}]	屯儿	'small village'
	[tɕ^{h}ɥẽ^{55}] + /ər/	→	[tɕ^{h}ɥəɻ^{55}]	群儿	'crowds of people'

The base words in (5) have open syllables whose nucleus is the front mid nasal vowel [ẽ]. I have argued in Chapter 2 that nasal vowels do not exist underlyingly. The input of [ẽ] is /ən/. During suffixation, the coda /n/ is replaced and /ə/ remains unchanged.

(6)	[xɛ^{55}] + /ər/	→	[xɐɻ^{55}]	孩儿	'kid'
	[ɕjɛ^{55}] + /ər/	→	[ɕjɐɻ^{55}]	鞋儿	'little shoes'
	[xwɛ^{55}] + /ər/	→	[xwɐɻ^{55}]	怀儿	'bosom'

The base words in (6) have open syllables whose nucleus is the front low oral vowel [ɛ]. The suffix is attached to the syllable, and /ɛ/ becomes the low central vowel [ɐ].

(7)	[pæ̃^{51}] + /ɚ/	→	[pɐɻ^{51}]	半儿	'kid'
	[tɕ^{h}jæ̃^{213}] + /ɚ/	→	[[tɕ^{h}jɐɻ^{213}]	签儿	'little label'
	[wæ̃^{55}] + /ɚ/	→	[wɐɻ^{55}]	玩儿	'to play'
	[ɥæ̃^{51}] + /ɚ/	→	[ɥɐɻ^{51}]	院儿	'small courtyard'

The base words in (7) have open syllables whose nucleus is the front low nasal vowel [æ̃]. I have argued in Chapter 2 that the front low nasal vowel [æ̃] has the input /ɐn/. Thus the suffixation process involves replacement of /n/ and the low vowel /ɐ/ remains unchanged.

(8)	[miŋ^{55}] + /ɚ/	→	[mĩɻ^{55}]	名儿	'fame'
	[yŋ^{35}] + /ɚ/	→	[ỹɻ^{35}]	蛹儿	'little pupa'
	[tʂuŋ^{213}] + /ɚ/	→	[tʂũɻ^{213}]	盅儿	'small cup'
	[fəŋ^{51}] + /ɚ/	→	[fə̃ɻ^{51}]	缝儿	'tiny flaw'
	[pɑŋ^{213}] + /ɚ/	→	[pɑ̃ɻ^{213}]	帮儿	'strap of shoes'
	[ljɑŋ^{51}] + /ɚ/	→	[ljɑ̃ɻ^{51}]	亮儿	'light'
	[xwɑŋ^{55}] + /ɚ/	→	[xwɑ̃ɻ^{55}]	黄儿	'egg yolk'

The base words in (8) have closed syllables with the velar nasal coda [ŋ]. The suffix replaces /ŋ/ but the nasal feature is preserved. The oral nuclear vowel becomes nasal.

(9)	[ti^{51}] + /ɚ/	→	[tjəɻ^{51}]	地儿	'little place'
	[tɕy^{51}] + /ɚ/	→	[tɕɥəɻ^{51}]	句儿	'sentence'

The base words in (9) have open syllables. The high vowels in base words become glides in suffixed words. This is because front vowels have articulatory conflicts with the rhotic suffix. Articulation of front vowels needs to move the tongue body forward, whereas articulation of the suffix curls back the tongue tip which physically retracts the tongue body. The mid central vowel /ə/ is inserted to solve the problem. /i, y/ tends to remain by means of glide formation.

(10) [tsɻ^{213}] + /ɚ/ → [tsɚ^{213}] 指儿 'finger'
[tʂɻ^{55}] + /ɚ/ → [tʂɚ^{55}] 侄儿 'nephew'

The base words in (10) have open syllables. I have argued in Chapter 2 that syllabic approximants do not exist underlyingly. They are prolongation of the preceding consonants. The inputs of base words shall be /ts/ and /tʂ/. Thus the suffix can be directly attached to the syllable and occupies the nuclear position.

Li (1983) uses the same IPA symbols [-əɻ] to represent the surface rime forms in (9) and (10). As my analysis shows, [-ə] after the glides [j-] or [ɥ-] is an inserted segment, whereas [-ɚ] after the stridents [ts-] or [tʂ-] is realized from the suffix. I propose that the vocalic feature is lost when the suffix occupies the coda position, and it is preserved when the suffix occupies the nuclear position. The difference can be attributed to certain markedness constraints on syllable positions.

(11) [tow^{51}] + /ɚ/ → [towˑ^{51}] 豆儿 'little bean'
[jow^{35}] + /ɚ/ → [jowˑ^{35}] 友儿 'buddy'

The base words in (11) have the coda [w] which results from glide formation of the vowel /u/. The suffix is compatible with a preceding /u/ and can be attached to the stem directly. But direct attachment causes a trouble to (11). It gives rise to a complex coda *[wɻ] which is not allowed in Xuzhou. I propose that /u/ and /ɚ/ at the coda position are contracted and produce the rhotacized [wˑ]. As a result, the derived syllable contains a simple coda bearing the rhotic feature of the suffix.

To sum up, the morphophonemic alternations under -ɻ suffixation are illustrated in (12), and generalizations are stated in (13).

(12) *Morphophonemic alternations under -ɻ suffixation*

a.	/-u+ə/	→	[-uɻ]
	/-ɔ+ə/	→	[-ɔɻ]
	/-ɑ+ə/	→	[-ɑɻ]
	/-ə+ə/	→	[-ɤɻ]
	/-e+ə/	→	[-əɻ]
	/-ɛ+ə/	→	[-ɐɻ]
	/-i+ə/	→	[-jəɻ]
	/-y+ə/	→	[-ɥəɻ]
b.	/-ən+ə/	→	[-əɻ]
	/-ɐn+ə/	→	[-ɐɻ]
c.	/-iŋ+ə/	→	[-ĩɻ]
	/-yŋ+ə/	→	[-ỹɻ]
	/-uŋ+ə/	→	[-ũɻ]
	/-əŋ+ə/	→	[-ə̃ɻ]
	/-ɑŋ+ə/	→	[-ɑ̃ɻ]
d.	/-ɔu+ə/	→	[-owˠ]
e.	/-□+ə/	→	[-əˠ]

(13) *Generalizations on morphophonemic alternations*

- When the stem does not have a coda, the suffix is attached as a coda.
  - (i) The central vowel becomes back.
  - (ii) The front non-high vowel becomes central.
  - (iii) The mid central vowel /ə/ is inserted, and the high front vowel becomes a glide.
- When the stem has a dental nasal consonant coda, the suffix replaces the coda.
- When the stem has a velar nasal consonant coda, the suffix replaces the coda, and the nuclear vowel becomes nasal.
- When the stem has a labial-velar glide coda, the coda becomes rhoticized.
- When the stem does not have a nucleus, the suffix is attached as a nucleus.

5.3 Previous studies on diminutive suffixation in Chinese dialects

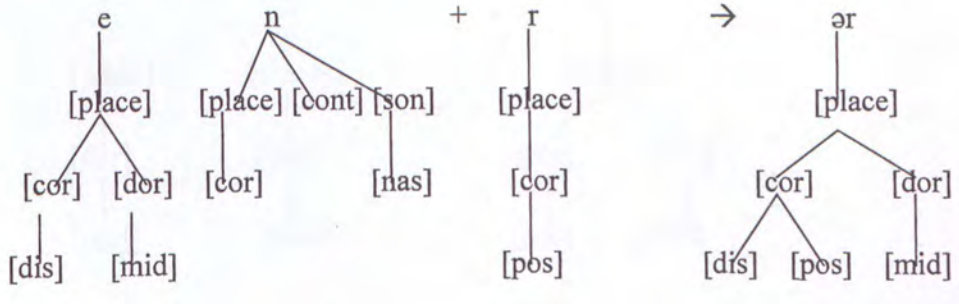
"*Er* suffixation" is a cover term in traditional Chinese phonology to label the morpho-phonological process of diminutive affixation. When *er* 儿 is a full word, it means 'son; child'. It can also function as a suffix to express the diminutive meaning. The suffix behaves as a full segment, a prosodic unit or a bundle of features in different Chinese dialects. In this section, I am going to review three different approaches that have been used to analyze Chinese diminutive suffixation and argue that the Optimality Theory is a theoretical model par excellence.

5.3.1 Feature-geometric approach

Mao (2003:54-58) adopts the model of feature geometry in Wang (1995, 1997) to analyze Xuzhou ɻ-suffixation. The suffix is viewed as a floating feature [posterior] under the place node [coronal]. The daughter feature [distributed] under [coronal] does not appear. The retroflex property is implied by the presence of [posterior] and the absence of [distributed].

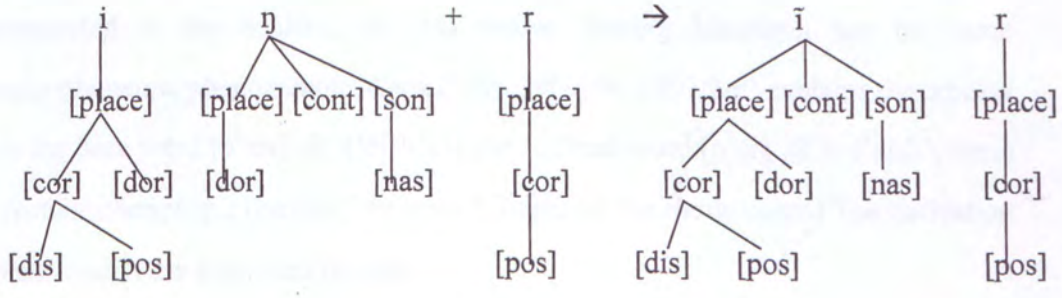
Three phenomena are discussed. First, [-ɛ, -æ̃, -e, -ẽ] in the base words become [-ɐɻ, -ɐɻ, -əɻ, -əɻ] in the suffixed words. Mao (2003:56) proposes that the underlying representations of the rimes shall be /ai, an, ei, en/, and the codas are changed by attaching the floating feature to the place node of /n/ or /i/. An example is shown below, where the IPA symbol 'r' denotes the diminutive suffix in his work.

(14) *Account for ɻ-suffixation to /-en/* (Mao 2003:56)



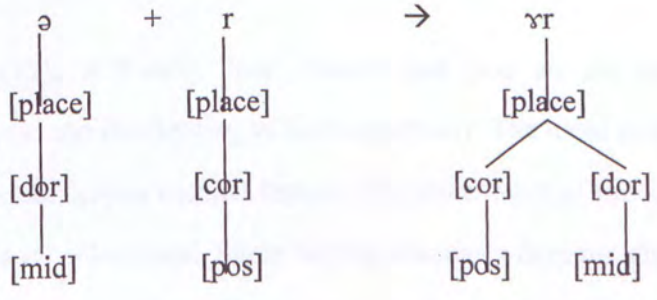
Second, he is interested in ɻ-suffixation to the base words with the velar nasal coda [-ŋ]. According to Mao (2003:57), the floating feature lands to the place node of /ŋ/ first. Since the duration of a Chinese syllable is fixed, the [dorsal] feature drops and the [nasal] feature reattaches to the nuclear vowel in order to operate the production of the retroflex sound. His account for ɻ-suffixation to /-iŋ/ is shown in (15).

(15) *Account for ɻ-suffixation to [-iŋ]* (Mao 2003:57)



Third, Mao addresses the change of [-ə] in the base word to [-ɤɻ] in the suffixed word. This is explained from the articulatory perspective. The mid central vowel /ə/ is produced with the tongue body at the neutral position. Production of the [pos] 'r' involves raising the tongue tip upward and curling it backward, and the tongue body is physically retracted. Coarticulation of /ə/ and the [pos] 'r' causes the tongue position of the vowel to move from central to back (Mao 2003:56). His analysis is illustrated in (16).

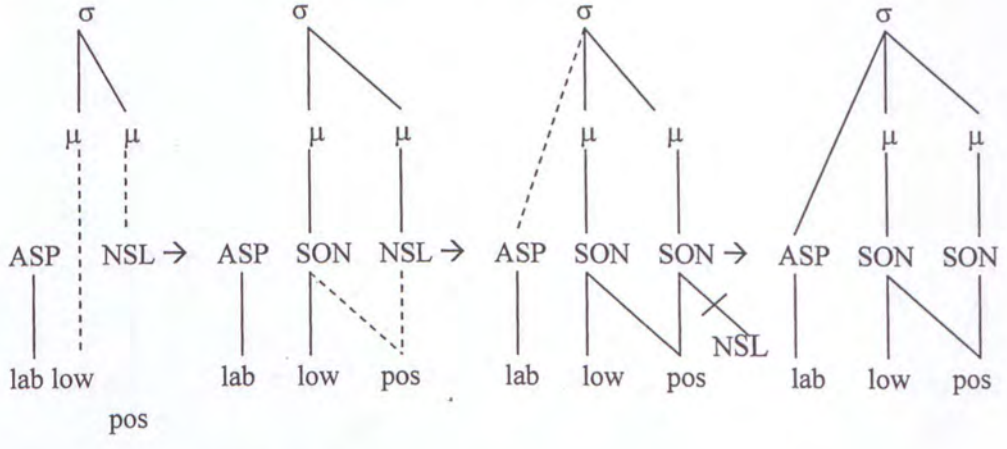
(16) *Account for ɻ-suffixation to /-ə/* (Mao 2003:56)



Mao's account makes contributions to the study of Xuzhou 儿-suffixation within the framework of generative phonology, and the analysis goes deep into features. His explanation for vowel changes in (16) is reasonable. However, the arguments in (14) and (15) are not strong. They have explanatory weakness. I am going to discuss them with reference to Wang (1993, 1997) where the geometry of segmental features in Beijing Mandarin is proposed and developed.

I begin with 儿-suffixation to the dental coda /-n/ in Xuzhou. The dental coda is changed. Mao suggests that the nasal segment is lost and the [pos] feature is incorporated in the nucleus, as (14) shows. Beijing Mandarin has the same morphophonemic phenomenon. Wang (1993:190-194; 1997:7-8) explains the process from the base word [p^{h}an] 盘 ('dish') to the suffixed word [p^{h}a̤r] 盘儿 ('dish', dim.) by *feature changing*. (The dot '̤' beneath [a̤] denotes the rhotic color.) The derivation is presented in the following schema.

(17) *Derivation of feature changing* (Wang 1993:192)

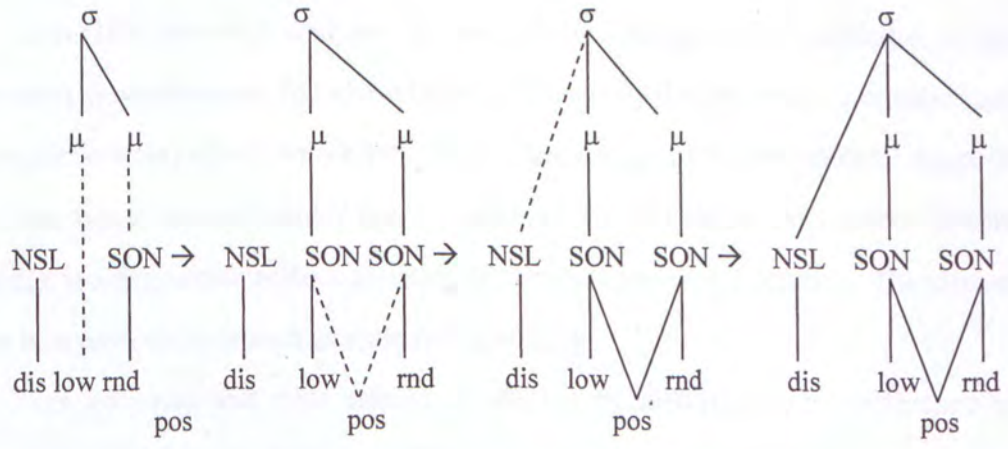


In (17), 'ASP-lab', 'low', 'nasal', and 'pos' are the feature representations of /p^{h}/, /a/, /n/ and the floating suffix respectively. The nasal coda has dental articulation which is the default coronal feature. The attachment of the feature [pos] changes the coda to a retroflex nasal. Since Beijing Mandarin does not allow a retroflex nasal, the feature [NSL] is delinked, and the root feature [SON] which dominates [NSL] is activated. The resultant rime consists of a retroflex vowel plus a retroflex coda.

On the contrary to (17), the analysis in (14) deletes the root node of the dental nasal /n/. It is not logical because the suffix does not have a root node and is not able to cause deletion of another root node. [pos] is dominated by the default coronal feature, and it is reasonable for the suffix to land under the root node of /n/. Mao's analysis lacks explanation for the root node deletion.

Next, I come to 儿-suffixation to the velar coda /-ŋ/ in Xuzhou. Mao proposes that the dorsal feature of /-ŋ/ drops because the duration of a Chinese syllable is fixed. Wang (1993, 1997) has discussed diminutive suffixation to rimes with velar codas in Beijing Mandarin. In this language, the velar coda becomes rhotacized in suffixed words. For instance, the base word [x^{w}aŋ] 黄 ('egg yolk') changes into [x^{w}ạŋ] 黄儿 ('egg yolk', dim.) (Wang 1997:2). She explains that *feature addition* applies to stem rimes which do not have the coronal articulator. The derivation of [n^{j}ạw̩] 鸟儿 ('bird', dim.) is presented as follows.

(18) *Derivation of feature addition* (Wang 1993:189)



In (18), 'NSL-lab', 'low', 'SON-rnd' and 'pos' are feature representations of /n^{j}/, /a/, /u/ and the floating suffix respectively. The default feature that dominates [pos] is coronal. It has no conflict with the dorsal feature of /u/, and can land beneath the place node of the coda. The incorporation of [pos] turns all the rime segments into complex segments, "with [pos] added to ALL existing features of the segments" (Wang 1993:188).

Since Mao states that his study follows the theoretical model in Wang (1995, 1997), the root node of /-ŋ/ in (15) shall not be deleted. Given that the suffix is a feature by Mao's assumption, it is possible to produce a rhotacized velar nasal coda. Then there is no problem with duration because only one segment occupies the coda position. But if so, the result becomes *[-ŋ˞] which distorts the real data in Xuzhou.

In sum, the feature geometry model does not suffice to account for the diminutive suffixation in Xuzhou. Wang's (1993, 1997) proposal is based on articulation. If the stem-final segment and the suffix are compatible, both are preserved. It has the inference that if two stem-final segments have the same place features, their compatibilities with the suffix shall be equal. For instance, both /u/ and /ŋ/ in Beijing Mandarin are preserved under suffixation. However, /u/ is preserved whereas /ŋ/ is dropped in Xuzhou. To explain this asymmetry, a context-free constraint shall be invoked to penalize the rhoticized velar nasal *[-ŋ˞].

5.3.2 Constraint-and-repair approach

Lin (1993:649-682) analyzes six cases of rime change under suffixation in four northern or northwestern Mandarin Chinese dialects by the operation of ordered rules in response to inviolable constraints. Rime change happens to stem-internal segments or tones under certain morphological conditions. The morpheme responsible for rime change is a degenerate suffix consisting of elements less than a segment. The element can be a prosodic unit such as mora (μ) or features.

Lin proposes that rime change is effected by affixation and conditioned by morphological output constraints. The surface expression of an affix results from interactions between the Affix Manifestation Principle (AMP) which requires affix preservation and templatic constraints, syllable-structure constraints or feature configurational constraints which prevent the complete expression of the affix. Lin's proposal can be illustrated by the analysis of "*er* rime change" in Jiyuan dialect at Henan province.

Jiyuan has three generalizations. First, the *er*-changed rimes tend to have fronted and rounded segments. Second, a front rounded glide [ɥ] is added to a non-low vowel. Third, a low vowel and its coda are merged. The generalizations suggest that the suffix is [-back, +round]. Two templatic constraints in (19) are at play. The first constraint states that a suffixed word is mono-syllabic and the second constraint states that a low vowel can not precede a coda.

(19) *Templatic constraints* (Lin 1993:664)

(a) σ (b) *μ μ]σ
|
[+lo]

Derivation from the stem /ɑi/ to the suffixed rime [ö] is shown in (20). CD is the *coda-delinking* rule. It is motivated by the templatic constraint (19b.). The stem coda *i* is deleted. FA is the *feature-association* rule. It is motivated by the AMP. The suffix [-back, +round] is associated to the root node projected by the unassociated μ. RR is the *redundancy rule*. It fills unspecified features. SM is the *segmental-merger* rule. It is motivated by the templatic constraint (19b.).

(20) *Derivation of er rime in Jiyuan* (Lin 1993:666)

CD → FA & RR → SM

μ μ μ μ
| | |
a i *a ɥ* *ö*

The insight of Lin (1993) is that rules are motivated by constraints. It has advantage over a rule-based analysis where rules are stipulated by language-specific phonological or morphological processes. A rule-based analysis misses the generalization that a group of rules are applied for a common purpose (Lin 2001:213).

The problem of Lin (1993) is that the analysis requires many language-specific stipulations. It is not as good as Optimality Theory. The OT analysis uses universal constraints to account for diverse cross-linguistic outputs, whereas the Lin's (1993)

analysis has both universal and language-particular constraints. Besides, rules in the latter are applied in response to constraints, indicating the crucial role of constraints in a grammar, and thus the theoretical status of rules is suspect (Lin 2001:195).

5.3.3 Optimality-theoretic approach

Lin (2001) discusses dialectal variation upon *er* suffixation in Zhejiang *Wu* dialects within the framework of Optimality Theory. The OT analysis accounts for the seemingly contradictory realizations of the suffix in seven Wu dialects by different rankings of the same set of universal constraints, rather than language-specific rules and constraints. It can be illustrated by the study of Wenzhou and Yiwu suffixations.

Four constraints and two constraint rankings are proposed to account for two-syllable outputs in Wenzhou and one-syllable outputs in Yiwu, shown in (21-22). *Max-st* is the constraint requiring that an input element in the stem has an output correspondent. *Max-af* requires that an input element in the affix has an output correspondent. *Uniformity* disallows coalescence. $*[af]_{pw}$ removes a prosodic word solely consisting of the affix. *[+nas,V] prevents a nasal vowel. This constraint shows up in (22) for a full citation of Lin (2001:205), and it does no harm to the discussion of dialectal variation.

(21) *Two-syllable output in Wenzhou* (Lin 2001:202)

dau + ŋ	Max-st	Max-af	Uniformity	$*[af]_{pw}$
☞ a. dau. ŋ				*
b. dau		*!		
c. daŋ	*!			
d. doŋ			*!	

(22) *One-syllable output in Yiwu* (Lin 2001:205)

μ μ | doŋ + n	*[+nas,V]	*[af]$_{pw}$	Max-af	Max-st	Uniformity
a. doŋ.n		*!			
b. do:ŋ			*!		
☞ c. do:n				*	
d. dõ:n	*!				*

The constraint ranking for Wenzhou is *Max-st, Max-af, Uniformity* >> **[af]$_{pw}$*. In (21), the suffix forms an entire syllable in candidate (a.). It violates *[af]$_{pw}$. Since the violated constraint is lower-ranked, this candidate wins. Candidate (b.) is eliminated by Max-af because it does not realize the suffix. Candidate (c.) is eliminated by Max-st because /u/ in the stem is deleted. Candidate (d.) contains coalescence of /a/ and /u/ into [o]. It violates Uniformity and is ruled out.

The ranking for Yiwu is **[+nas,V], *[af]$_{pw}$, Max-af >> Max-st >> Uniformity.* In (22), the suffix forms an entire syllable in candidate (a.). It is eliminated by the constraint *[af]$_{pw}$. Candidate (b.) is eliminated by Max-af because it does not realize the suffix. Candidate (c.) deletes /u/ in the stem. It wins because the violated constraint Max-st is lower-ranked. Candidate (d.) has a nasal vowel. It violates the undominated *[+nas,V] and fails in the competition.

Zhang (2000) studies a particular issue in Chinese diminutive suffixation within the framework of OT. He examines the interaction between the diminutive suffix and the nasal codas of base words in Beijing Mandarin and other Chinese dialects. The suffix is assumed to be a full segment /-ɻ/. Upon Beijing ɻ-suffixation, the nasal codas in both /CVn/ and /CVŋ/ are lost, the vowel in /CVn+ɻ/ remains oral, but the vowel in /CVŋ+ɻ/ becomes nasal.

Zhang hypothesizes that in the base words, the nasality induced by the /ŋ/-coda is perceptually more salient than the nasality induced by the /n/-coda. It is tested by an aerodynamic experiment. Results show that (i.) the vowel in /CVŋ/ has longer nasal airflow duration than the vowel in /CVn/, and (ii.) the proportion of the nasal

airflow in the overall glottal airflow during the nasalized portion of the vowel in /CVŋ/ is no less than during the nasalized portion of the vowel in /CVn/. Hence the hypothesis is supported.

Zhang (2000:427) argues that the realization difference between /CVŋ+ɻ/ and /CVn+ɻ/ reflects the difference in their stem forms. He proposes two constraints *MAX[+nas]*$_{ŋ}$ and *MAX[+nas]*$_{n}$ to distinguish faithfulness to the nasal features of /ŋ/ and /n/. Max[F] is different from Ident[F]. When an input segment is completely deleted in the output, Max[F] is violated whereas Ident[F] is vacuously satisfied (Zhang 2000:430).

19 Chinese dialects with two nasal codas /n/ and /ŋ/ are investigated. An implicational hierarchy is observed. That is, if the nasalization of /n/ is preserved, the nasalization of /ŋ/ is preserved (Zhang 2000:448). Thus MAX[+nas]$_{n}$ never outranks MAX[+nas]$_{ŋ}$.

The constraint rankings for *Beijing* and *Liaocheng* are presented in (23-24). Dialectal variation is explained by different rankings of the same set of universal constraints. TEMPLATE is the templatic constraint requiring that suffixed forms must be mono- syllabic. MAX[+nas]$_{ŋ}$ requires that [+nasal] of the input /ŋ/ is preserved in the output. *V_{nas} penalizes a nasalized vowel in non-nasal environments. MAX[+nas]$_{n}$ requires that [+nasal] of the input /n/ is preserved in the output. REALISEAFFIX and *COMPLEXCODA are not present in the tableaux because they are undominated in all these dialects.

(23) *Constraint ranking for Beijing* (Zhang 2000:441)

a.

CVn+ɻ	TEMPLATE	MAX[+nas]$_{ŋ}$	*V_{nas}	MAX[+nas]$_{n}$
☞ CV.ɻ				*
CVn.ɻ	*!			
CVɻ			*!	

b.

CVŋ+ɻ				
☞ CV.ɻ			*	
CVŋ.ɻ	*!			
CVɻ		*!		

(24) *Constraint ranking for Liaocheng* (Zhang 2000:450)

a.

CVn+ɻ	TEMPLATE	*V_{nas}	MAX[+nas]$_{ŋ}$	MAX[+nas]$_{n}$
☞ CVɻ				*
CVn.ɻ	*!			
CVɻ		*!		

b.

CVŋ+ɻ				
CVɻ		*!		
☞ CVɻ			*	
CVŋ.ɻ	*!			

As (23) and (24) show, when the input is /CVn+ɻ/, both dialects have the output [CVɻ] because *V_{nas} outranks Max[+nas] in both grammars. When the input is /CVŋ+ɻ/, the output in Beijing is [CVɻ]. It has a nasal vowel before a non-nasal segment. This candidate wins because MAX[+nas]$_{ŋ}$ overrides *V_{nas} and [+nasal] of /ŋ/ is preserved at the expense of violating lower-ranked *V_{nas}. On the contrary, the output in Liaocheng is [CVɻ]. The optimal candidate has an oral vowel because *V_{nas} dominates MAX[+nas]$_{ŋ}$ and a nasal vowel would incur fatal violation. Disyllabic candidates never win because both dialects have the undominated constraint TEMPLATE which demands mono-syllabic suffixed words.

Lin (2001) has two major insights. First, suffixation can be studied by a constraint-based theoretical model. Rules no longer take a place in phonology and morphology. Second, suffixation in different Chinese dialects can be explained by the same set of constraints. The constraints are universal and thus they are found in different grammars. The ranking of constraints are language-particular. The cross-dialectal difference results from different constraint rankings.

The insightful idea in Zhang (2000) is that the nasal features of /ŋ/ and /n/ shall be treated differently. It explains why the vowels before /ŋ/ and /n/ could have different realizations in suffixed words. The proposal of MAX[+nas]$_{ŋ}$ >> MAX[+nas]$_{n}$ as a fixed ranking across Chinese dialects contributes to the study of linguistic typology.

5.4 Optimality-theoretic account

This section aims to provide an optimality-theoretic account for the generalizations drawn in section 5.2. Subsections are arranged according to different types of morphophonemic processes. The constraints at work and their interactions are examined. The constraint hierarchy is proposed at the end of each subsection. Besides, the interaction of vowel retraction/insertion and coda deletion is analyzed by the sympathy theory within the framework of OT.

5.4.1 Suffixation

At the beginning of this chapter, I assume that the diminutive suffix is /-ɚ/. It is one segment with both the vocalic feature and the rhotic feature. The semantic meaning of the suffix is carried by the rhotic feature.

There are two observations in Xuzhou ɻ-suffixation. First, when the stem does not have a coda, [-ɻ] becomes the coda of the suffixed word. Second, when the stem does not have a nucleus, [ɚ] becomes the nucleus of the suffixed word. They are exemplified in (25a.) and (25b.) respectively.

(25)	a.	/pʰu + ɚ/	→	[pʰuɻ^{51}]	铺儿	'small shop'
		/mɑ + ɚ/	→	[mɑɻ^{35}]	码儿	'small pieces'
	b.	/ts + ɚ/	→	[tsɚ^{213}]	指儿	'finger'
		/tʂ + ɚ/	→	[tʂɚ^{55}]	侄儿	'nephew'

In both data sets, the suffix is attached to the stems. It indicates that the suffix must be realized. Besides, both the stem and the suffixed word are mono-syllabic, showing that the suffix must be syllabified in the same syllable. These facts satisfy the markedness constraints in (26) and (27).

(26) REALISEAFFIX (Zhang 2000:440)
'Affixes must be realized.'

(27) TEMPLATE (Zhang 2000:440)
'The suffixed form must be one syllable.'

The vocalic feature of the suffix drops in (25a.) but it is preserved in (25b.). The difference can be attributed to the distinct syllable positions of the suffix. If /ɚ/ was realized as a coda *[-ɚ], the suffixed word would have a vowel coda. It violates the constraint in (28). The specific content of 'λ' is 'V' here, shown in (29).

(28) *COD/λ (Prince and Smolensky 2004:170)
'No λ coda.'

(29) *COD/V
'No vowel coda.'

The realization of [-ɻ] at the coda position is paid off by violation of the faithfulness constraint in (30), which penalizes the change of [-consonantal] feature between input and output correspondents.

(30) IDENT(-cons)
'Correspondents in input and output have identical [-cons] feature.'

The analysis of (25a.) is illustrated in the tableau (31). Candidate (a.) does not have the suffix. It violates REALISEAFFIX which requires realization of all affixes. Candidate (b.) has the suffix which is syllabified into the next syllable. It violates the mono-syllabic template but satisfies the *COD/V requirement. Candidate (c.) has a vowel coda and violates *COD/V. Candidate (d.) preserves the suffix by keeping the rhotic feature and losing the vocalic feature. It satisfies the constraints overriding IDENT(-cons) and is selected. IDENT(-cons) is sacrificed, indicating its lower ranking.

(31)

Input: /mɑ+ɚ/	REALISEAFFIX	TEMPLATE	*COD/V	IDENT(-cons)
a. mɑ	*!			
b. mɑ.ɚ		*!		
c. mɑɚ			*!	
d. ☞ mɑɻ				*

The data in (25b.) can also be explained. An example is shown in the tableau (32). Candidates (a.) and (b.) have the same problems with (31a.) and (31b.) respectively. Candidate (c.) violates IDENT(-cons) because the vocalic feature is missing. Candidate (d.) satisfies all the constraints and becomes the winner.

(32)

Input: /ts+ɚ/	REALISEAFFIX	TEMPLATE	*COD/V	IDENT(-cons)
a. ts	*!			
b. ts.ɚ		*!		
c. tsɻ				*!
d. ☞ tsɚ				

The constraint hierarchy can be summarized in (33), where '>>' denotes 'crucial outranking'.

(33) REALISEAFFIX, TEMPLATE, *COD/V >> IDENT(-cons)

5.4.2 Vowel retraction

Vowel retraction in Xuzhou ɻ-suffixation occurs in the stems with open syllables. Under ɻ-suffixation, the non-high vowels become central and the mid central vowel becomes back. Examples are provided in (34).

(34)	a.	/pe + ɚ/	→	[pəɻ^{51}]	辈儿	'generation'
		/kwe + ɚ/	→	[kwəɻ^{51}]	柜儿	'small cabinet'
		/xɛ + ɚ/	→	[xɐɻ^{55}]	孩儿	'kid'
		/xiɛ + ɚ/	→	[ɕjɐɻ^{55}]	鞋儿	'little shoes'
	b.	/kə + ɚ/	→	[kɤɻ^{51}]	个儿	'body height'
		/t^{h}iə + ɚ/	→	[t^{h}jɤɻ^{55}]	蝶儿	'butterfly'

Both data sets in (34) show the change of vowel backness. The conditioning environment is the suffix /ɚ/. ɻ-suffixation involves a retroflex movement of the tongue tip. The articulator is raised and curled back. The suffix itself involves a [+back] feature which is parallel to [posterior] in Mao's (2003) discussion within the feature geometry model.

The change of vowel backness implies a requirement that the vowel preceding the rhotic suffix must be [+back]. While both [-ɻ] and [-ŋ] are back segments, [-ŋ] can follow a front vowel. For instance, in the legitimate syllable [t^{h}iŋ] 听 ('listen'), the [-back] vowel [i] and the [+back] nasal [ŋ] are compatible. This is because articulation of the velar [ŋ] involves raising the back of the tongue against the velum. It does not include any backward movement of the tongue and thus has no influence on the preceding vowels. Therefore, the backness agreement only applies to [-ɻ]. The markedness constraint in (35) plays a role.

(35) *V$_{[-bk]}$ɻ
'No [-back] vowel before the retroflex approximant.'

(34a.) and (34b.) differ in the vowel backness of suffixed words. In (34a.), front vowels become central rather than back. Central vowels are [+back] in nature. The change satisfies *V$_{[-bk]}$ɻ. The vowels do not change to back to be faithful to the

original feature value as much as possible. The faithfulness constraint at work is in (36).

(36) IDENT (back)
'Correspondents in input and output have identical backness value.'

Interaction of the above two constraints can be illustrated in the tableau (37). The vowel in candidate (a.) remains front. Its backness value is different from the suffix and violates *$V_{[-bk]}$ɻ. The vowel in candidate (b.) changes to central. It satisfies *$V_{[-bk]}$ɻ but violates IDENT(bk). The vowel in candidate (c.) changes to back. It incurs fatal violation of IDENT(bk). Candidate (b.) wins the competition because it reaches a compromise between the two constraints.

(37)

Input: /pe + ɚ/	*$V_{[-bk]}$ɻ	IDENT(bk)
a. peɻ	*!	
b. ☞ pəɻ		*
c. pʏɻ		*!*

In addition to these two constraints, the constraints in (33) are in need to realize the suffix at the coda position. Full analysis of vowel retraction is illustrated in (38).

(38)

Input: /xɛ+ɚ/	REALISE AFFIX	TEMPLATE	*COD/V	*$V_{[-bk]}$ɻ	IDENT (bk)	IDENT (-cons)
a. xɛ	*!					
b. xɛ.ɚ		*!				
c. xɛɚ			*!	*		
d. xɛɻ				*!		*
e. xɑɻ					*!*	*
f. ☞ xɐɻ					*	*

In (38), candidate (a.) does not have the suffix. It violates REALISEAFFIX. Candidate (b.) syllabifies the suffix into another syllable. It violates TEMPLATE. Candidate (c.) has a vowel coda and the nucleus does not agree with the coda in backness. It violates both *COD/V and *$V_{[-bk]}$ɻ. The nucleus in candidate (d.) does not agree with the coda in backness, and the vocalic feature of the suffix is missing. It

violates both *$V_{[-bk]}$ɻ and IDENT(-cons). Candidate (e.) incurs fatal violation to IDENT(back) because the vowel changes two degrees of backness. It also violates IDENT(-cons) due to lack of the input vocalic feature in the suffix. Candidate (f.) is similar to (e.) but its violation to IDENT(back) is mild. It is selected as the optimal output because the constraints it violates are lowered-ranked.

While front vowels change to central in (34a.), the central vowel changes to back in (34b.). The stepwise retraction needs to be explained. The change from /ə/ to [ɤ] indicates that the [+back] property of the central vowel and the back vowel has different degrees. It is weak in the central vowel and strong in the back vowel. In this regard, the -əɻ in stem does not show strong respect to the constraint *$V_{[-bk]}$ɻ, and the retraction is called on. Although the vowel backness change violates IDENT(back), the violation is tolerable because the faithfulness constraint is lower-ranked. The constraint interaction is illustrated in (39).

(39)

Input: /kə + ə˞/	*$V_{[-bk]}$ɻ	IDENT(bk)
a. kəɻ	*!	
b. ☞ kɤɻ		*

Full analysis of the central vowel retraction will not be discussed because the constraint hierarchy for the front vowel retraction is adequate to explain both. It can be summarized in (40).

(40) REALISEAFFIX, TEMPLATE, *COD/V >> *$V_{[-bk]}$ɻ
>> IDENT(bk), IDENT(-cons)

5.4.3 Vowel insertion

Vowel insertion is found between high front vowels in stems and the suffix. The data are shown in (41). The IPA symbol 'ɚ' in the input is different from 'ə' in the output. /ɚ/ in the input denotes the suffix. [ə] in the output is an inserted segment.

(41)	/ti + ɚ/	→	[tjəɻ^{51}]	地儿	'little place'
	/ky + ɚ/	→	[tɕɥəɻ^{51}]	句儿	'small sentence'

/i/ and /y/ are front vowels. Their backness value does not agree with the [+back] suffix. It is logically possible to change them to central or back vowels. The previous subsection shows that changing front vowels to central is a better solution, because it respects the markedness constraint *V$_{[-bk]}$ɻ and does not violate the faithfulness constraint IDENT(back) seriously. Vowel retraction will generate suffixed words such as *[tiɻ] or *[tɕɯɻ].

The high central vowels do not show up in (41) because Xuzhou does not allow any high central vowel. The markedness constraint in (42) is at work. I use the symbol 'ɨ' to represent any high central vowel.

(42) *ɨ
'No high central vowel.'

Under the pressure of *ɨ, the mid central vowel is inserted to entertain the backness agreement. The cost is violation of the faithfulness constraint DEP-IO that requires an output has an input correspondent. The specific constraint in Xuzhou is DEP-V-IO defined in (43).

(43) DEP-V-IO
'No vowel insertion.'

When /ə/ is inserted between /i/ and the suffix, /i/ can be realized at the medial position through glide formation. However, mid vowels cannot become glides and they must stay at the nuclear position. If /ə/ is inserted between /ɛ/ and the suffix, it will create a complex nucleus *[-ɛə-]. The constraint in (44) prohibits its occurrence

in speech. This explains why vowel retraction happens to non-high vowels and vowel insertion happens to high vowels.

(44) *COMPLEX^{NUC}
'Nuclei are simple.'

The analysis of vowel insertion can be illustrated in the tableau (45). The basic constraints for suffixation 'REALISEAFFIX, TEMPLATE, *COD/V, IDENT(-cons)' are not shown to avoid redundancy. Their interactions with *V$_{[-bk]}$ɻ and IDENT(back) have been illustrated in (38).

(45)

Input: /ti+ə/	*COMPLEX^{NUC}	*ɨ	*V$_{[-bk]}$ɻ	IDENT(bk)	DEP-V-IO
a. tiɻ			*!		
b. tɨɻ		*!		*	
c. tɯɻ				*!*	
d. ☞ tjəɻ					*

The vowel in candidate (a.) does not agree with the suffix in the backness value. It violates *V$_{[-bk]}$ɻ. The vowel in candidate (b.) incurs fatal violation of *ɨ and its change to central violates IDENT(back) once. The vowel in candidate (c.) incurs IDENT(back) twice because the backness is changed by two degrees. A vowel is inserted in candidate (d.). It violates DEP-V-IO but satisfies the higher-ranked constraints. Hence it is selected. The constraint hierarchy can be summarized in (46).

(46) REALISEAFFIX, TEMPLATE, *COD/V, *ɨ, *COMPLEX^{NUC} >> *V$_{[-bk]}$ɻ >> IDENT(bk), IDENT(-cons), DEP-V-IO

5.4.4 Coda deletion and vowel nasalization

The nasal coda in stems is deleted under ɻ-suffixation. If the coda is a velar nasal /ŋ/, the oral nuclear vowel in stems become nasal in suffixed words. If the coda is a dental nasal /n/, the vowel in stems remains oral. The data is show in (47).

(47)	a.	/miŋ + ɚ/	→	[mĩɻ^{55}]	名儿	'fame'
		/fəŋ + ɚ/	→	[fə̃ɻ^{51}]	缝儿	'tiny flaw'
		/pɑŋ + ɚ/	→	[pɑ̃ɻ^{213}]	帮儿	'strap of shoes'
	b.	/pən + ɚ/	→	[pəɻ^{35}]	本儿	'notebook'
		/wɐn + ɚ/	→	[wɐɻ^{55}]	玩儿	'to play'

The nasal segments are deleted because they can not co-exist with [ɻ] at the coda position in suffixed words. Their co-existence would cause complex coda such as *[-ŋɻ] or *[-nɻ] in a syllable. In Xuzhou, the coda position can be occupied by at most one segment. The markedness constraint in (48) takes effect.

(48) *COMPLEX^{COD} (Kager 1999:97)
'Codas are simple.'

A solution to avoid the complex coda is to contract the consonants and produce a retroflex nasal *[ɳ]. This segment preserves the coda in the stem and realizes the suffix by obtaining its rhotic feature. Absence of *[ɳ] in Xuzhou is enforced by the markedness constraint in (49).

(49) *ɳ
'No retroflex nasal.'

Since (49) blocks coda contraction and REALISEAFFIX requires that the suffix must be realized, the nasal segment is deleted. The deletion violates the lower-ranked faithfulness constraint in (50).

(50) MAX-N-IO/COD
'Input nasal segments must have output correspondents at the coda position.'

Interaction of the above three constraints can be instantiated in the tableaus (51).

(51)

Input: /wɐn+ ɚ/	REALISEAFFIX	*COMPLEX^{COD}	*ɳ	MAX-N-IO/COD
a. wɐn	*!			
b. wɐnɻ		*!		
c. wɐɳ			*!	
d. ☞ wɐɻ				*

Candidate (a.) does not realize the suffix /-ɚ/. It violates REALISEAFFIX. Candidate (b.) realizes the suffix but has two segments at the coda position. It violates *COMPLEX^{COD}. Candidate (c.) has a retroflex nasal. It violates *ɳ. Candidate (d.) achieves affix realization and avoids violation of the coda constraint. Deletion of the nasal segment violates the faithfulness constraint MAX-N-IO/COD. Since this constraint is overridden by others, the violation is tolerable. As a result, candidate (d.) is the winner.

Deletions of two nasal segments are different. While /-n/ is deleted completely, the nasal feature of /-ŋ/ is preserved in the nuclear vowel. Zhang (2000:427-478) discusses similar phenomena in Beijing Mandarin. He proposes the constraints in (52) and (53) to distinguish faithfulness to the nasal features of /ŋ/ and /n/.

(52) MAX[+nas]$_{ŋ}$ (Zhang 2000:440)
'If /ŋ/ is the input, then [+nasal] must be in the output.'

(53) MAX[+nas]$_{n}$ (Zhang 2000:440)
'If /n/ is the input, then [+nasal] must be in the output.'

Zhang (2000:439) considers that if a segment has a stronger nasal percept, its nasal feature is more faithfully preserved. The ranking in (54) is posited to explain nasal feature preservation in /CVŋ+ɻ/ and complete nasal deletion in /CVn+ɻ/.

(54) MAX[+nas]$_{ŋ}$ >> MAX[+nas]$_{n}$ (Zhang 2000:440)

Return to the data in Xuzhou. The nasal feature of /ŋ/ is preserved to satisfy the faithfulness constraint MAX[+nas]$_{ŋ}$. The nasal feature of /n/ is lost because it will create a nasalized vowel which is disallowed by the constraint in (55).

(55) *V_{NASAL} (Kager 1999:28)
'Vowels must not be nasal.'

The constraint interactions can be illustrated in the following tableaux.

(56)

Input: /pɑŋ+ə/	MAX[+nas]$_{ŋ}$	*V_{NASAL}	MAX[+nas]$_{n}$
a. pɑɻ	*!		
b. ☞ pɑ̃ɻ		*	

(57)

Input: /pən+ə/	MAX[+nas]$_{ŋ}$	*V_{NASAL}	MAX[+nas]$_{n}$
a. ☞ pəɻ			*
b. pə̃ɻ		*!	

In (56), the input nasal segment is /ŋ/. Candidate (b.) wins over candidate (a.) because MAX[+nas]$_{ŋ}$ outranks *V_{NASAL}. The nasal vowel preserves the nasal feature of /ŋ/ and is selected. In (57), the input segment is /n/. Candidate (a.) wins over candidate (b.) because *V_{NASAL} outranks MAX[+nas]$_{n}$. A nasal vowel is forbidden at the cost of losing the nasal feature.

The analysis of coda deletion and vowel nasalization is illustrated in (58).

(58)

Input: /pɑŋ+ə/	REALISEAFFIX	TEMPLATE	*COD/V	*COMPLEX^{COD}	MAX[+nas]$_{ŋ}$	*V_{NASAL}	MAX[+nas]$_{n}$	MAX-N-IO /COD	IDENT(-cons)
a. pɑŋ	*!								
b. pɑŋ.ə		*!							
c. pɑŋə			*!	*					
d. pɑŋɻ				*!					*
e. pɑɻ					*!			*	*
f. ☞ pɑ̃ɻ						*		*	*

I will not explain the tableau to avoid redundancy with (51) and (56-57), but a final remark needs to be addressed on the constraint rankings. (58) carries two messages. First, as long as the first four constraints 'REALISEAFFIX, TEMPLATE, *COD/V, *COMPLEX^{COD}' are undominated, candidates (a.-d.) are ruled out. Second, as long as 'MAX[+nas]$_{ŋ}$ >> *V$_{NASAL}$ >> MAX[+nas]$_{n}$' is ensured, candidate (f.) can win over candidate (e.). The nasal deletion constraints do not have crucial ranking relation with the constraints MAX-N-IO/COD or IDENT(-cons). Therefore, the constraint hierarchies can be summarized in (59) and (60) separately.

(59) REALISEAFFIX, TEMPLATE, *COD/V, *COMPLEX^{COD}, MAX[+nas]$_{ŋ}$ >> MAX-N-IO/COD, IDENT(-cons)

(60) MAX[+nas]$_{ŋ}$ >> *V$_{NASAL}$ >> MAX[+nas]$_{n}$

5.4.5 Coda contraction

When the stem has a vowel at the coda position, the coda and the suffix are contracted and produce a rhotacized segment in the suffixed word. The data is shown in (61).

(61) /tɔu + ɚ/ → [towˠ^{51}] 豆儿 'little bean'
/iɔu + ɚ/ → [jowˠ^{35}] 友儿 'buddy'

Preservation of the vowel coda satisfies the constraint in (62) which prohibits /u/-deletion.

(62) MAX-*u*-IO/COD
'The input /u/ has an output correspondent at the coda position.'

Co-existence of the stem coda and the suffix would produce *[-wɻ] and violate *COMPLEX^{COD} which requires simple codas. The compromise is reached by contracting two segments into one. The analysis of coda contraction is illustrated in (63). Since vowel-raising and glide-formation are not morphophonemic processes, their constraints are not included.

(63)

Input: /tɔu+ɚ/	REALISE AFFIX	TEMPLATE	*COD/V	*COMPLEX^{COD}	MAX-*u*/COD	IDENT (-cons)
a. tow	*!					
b. tow. ɚ		*!				
c. towɚ			*!	*		
d. towɻ				*!		*
e. toɻ					*!	*
f. ☞ towˠ						*

Candidate (a.) does not realize the suffix. It violates REALISEAFFIX. Candidate (b.) syllabifies the suffix into another syllable. It violates TEMPLATE. Candidate (c.) preserves the vocalic feature at the coda position. It violates *COD/V. Besides, two segments occupy the coda position, violating *COMPLEX^{COD}. Candidate (d.) also has a disfavored complex coda. Candidate (e.) incurs fatal violation of MAX-*u*-IO/COD

which does not allow /u/-deletion. Candidates (d.-f.) lose the vocalic feature of the suffix and violate IDENT(-cons). Since this constraint is lower-ranked, the violation is tolerable. As a result, candidate (f.) is selected. The constraint hierarchy can be summarized in (64).

(64) REALISEAFFIX, TEMPLATE, *COD/V, *COMPLEX^{COD}, MAX-*u*-IO/COD >> IDENT(-cons)

5.4.6 Suppression of vowel retraction/insertion under coda deletion

Vowel retraction and vowel insertion in open syllables have been discussed in sections 5.4.2 and 5.4.3. The generalization is that vowels before the coda [-ɻ] must be [+back] in surface forms. However, this generalization is disabled when the stem has a closed syllable. For instance, the suffixed word [mĩɻ] 名儿 ('fame') has a front vowel [ĩ] before [-ɻ]. Its underlying representation is /miŋ+ɚ/. An intervening coda separates the nucleus from the suffix but it is not realized in suffixed words. This is a linguistic phenomenon of non-surface-true opacity. Within the framework of OT, the phonological opacity can be explained by the sympathy theory.

5.4.6.1 Sympathy theory

The sympathy theory is proposed by McCarthy (1999:331-399) to accommodate the phonological opacity within the framework of OT. There are two types of opacities. One is *non-surface-apparent opacity*. Linguistic generalizations can give rise to surface forms. If the crucial condition for a generalization to apply is invisible in the surface form, the over-application is *non-surface-apparen*t. The other is *non-surface-true opacity*. If the crucial condition is visible in the surface form but the generalization does not apply, the under-application is *non-surface-true*.

An example of non-surface-apparent opacity can be drawn from Tibetan Hebrew (McCarthy 1999:333). This language has interaction of epenthesis and deletion. The input /dešʔ/ undergoes vowel epenthesis (*dešeʔ*) and glottal deletion (*deše*). The output [deše] with an inserted vowel [e] does not show the conditioning environment of the word-final consonant cluster.

Bedouin Arabic supplies an example of non-surface-true opacity (McCarthy 1999:334). The low vowel /a/ is raised to [i] in open syllables. However, the input /badw/ undergoes vocalization and becomes [badu]. The surface [a] in an open syllable is not raised.

McCarthy assumes that certain non-surface representation plays an active role in opacity. In Hebrew, *dešeʔ* with a glottal stop establishes a relation between /dešʔ/

and [deše]. In Bedouin Arabic, *badw* is a closed syllable and thus vowel-raising is blocked. Even though *[deše?] and *[badw] fail to surface, they contribute to select the outputs.

The sympathy theory offers an account for opacity in terms of core OT postulate, constraint rankings and violation (McCarthy 1999:334). The idea is that a designated failed candidate has an influence on the optimal candidate. The designated failed candidate is the *sympathetic candidate*. It is the one in which the opaque process occurs transparently. It has an input-output faithfulness relation with the input, and a *sympathy relation* with the output. *Sympathy* is an inter-candidate faithfulness (McCarthy 1999:336).

The faithfulness constraint that selects the sympathetic candidate is *selector*. The choice of a selector is language-specific. The faithfulness constraint that mediates the influence of the sympathetic candidate on the output is *sympathy constraint*. Dependency of the sympathetic candidate on the input or dependency of the output on the sympathetic candidate shall be understood as constraint satisfaction in parallel rather than serially (McCarthy 1999:349).

Notations in the sympathy theory are exemplified in (65).

(65) Sympathy applied to non-surface-apparent opacity (McCarthy 1999:336)

/dešʔ/	CODACOND	*COMPLEX	⊛MAX-V	☆MAX-C	DEP-V
a. ☞ deše				*	¡*
b. ☜ deš			*!	*	
c. ⊛ dešeʔ	*!			✓	*
d. dešʔ	*!	*!	*!	✓	

(65) shows application of sympathy to non-surface-apparent opacity in Hebrew. (c.) is the sympathetic candidate, indicated by '⊛'. It is chosen by the selector ☆MAX-C, indicated by '☆'. Satisfaction to the selector is signaled by '✓'. (d.) is not chosen as the sympathetic candidate because it incurs more serious violations than (c.) does. ⊛MAX-V is the sympathetic constraint, indicated by '⊛'. (b.) is a transparent candidate, indicated by '☜'. Without ⊛MAX-V, (b.) would win. (a.) is the opaque

and optimal candidate, indicated by '☞'. Without ⊛MAX-V, (a.) would incur fatal violation of DEP-V and lose. Real fatal violations are signaled by '!' whereas the gratuitous violation by the optimal candidate is signaled by '¡'.

Implementation of the sympathy theory is instantiated in (66).

(66) Sympathy applied to non-surface-true opacity (McCarthy 1999:338)

/badw/	*COMPLEX	⊛ID(hi)	*a]$_\sigma$	ID(hi)	☆DEP-μ
a. ☞ [ba]$_\sigma$[du]$_\sigma$			¡*		*
b. ☜ [bi]$_\sigma$[du]$_\sigma$		*!		*	*
c. ⊛ [badw]$_\sigma$	*!				✓

(66) shows application of sympathy to non-surface-true opacity in Bedouin Arabic. (c.) is the sympathetic candidate. It is chosen by the selector ☆DEP-μ because (c.) has the same syllable weight with the input. It is ruled out since the complex coda violates *COMPLEX. The glide /w/ becomes vowel in (a.-b.) and their syllable weights are increased. ☆DEP-μ is violated. (b.) is the transparent candidate. If the sympathetic constraint ⊛ID(hi) did not exist, (b.) would be selected. ⊛ID(hi) requires that the height features of other candidates are identical to the sympathetic candidate. In this regard, (a.) wins over (b.). Since *a]$_\sigma$ is lower-ranked than ⊛ID(hi), violation of *a]$_\sigma$ is less serious than violation of ⊛ID(hi). Thus (a.) is selected.

5.4.6.2 Sympathy in Xuzhou ɻ-suffixation

Xuzhou ɻ-suffixation has non-surface-true opaque phenomena. Examples are provided in (67). (67a.) shows that a central vowel becomes back after suffixation. The markedness constraint *V$_{[-bk]}$ɻ is introduced in previous sections to account for vowel retraction. But suffixed words in (67b.-c.) violate the constraint in that the underlying central vowel remains the same in surface forms. Similarly, (67d.) has an inserted vowel [ə] under suffixation. It satisfies *V$_{[-bk]}$ɻ by separating the front vowel from [-ɻ]. Yet the suffixed word in (67e.) violates the constraint because the front vowel precedes [-ɻ] adjacently.

(67) a. /kə + ɚ/ → [kɤɻ^{51}] 个儿 'body height'
b. /kən + ɚ/ → [kəɻ^{213}] 跟儿 'heel'
c. /kəŋ + ɚ/ → [kə̃ɻ^{51}] □儿 'pause in speech'

d. /mi + ɚ/ → [mjəɻ^{35}] 米儿 'rice grains'
e. /miŋ + ɚ/ → [mĩɻ^{55}] 名儿 'fame'

(67a.-c.) involve two phonological processes, vowel retraction and coda deletion. Vowel retraction is enforced by the markedness constraint *V$_{[-bk]}$ɻ, and coda deletion is enforced by *COMPLEX^{COD} which requires simple codas. The former is suppressed when the latter occurs. This is a sympathy effect. The sympathetic candidate is selected by the constraint ☆MAX-N-IO/COD so that it is faithful to the input by preserving the nasal coda. The sympathetic constraint ֍IDENT(bk) tests the output candidates against the sympathetic candidate for matching vowel backness. The opaque candidate satisfies this constraint whereas the transparent candidate violates it. By ranking the sympathetic constraint above the markedness constraint *V$_{[-bk]}$ɻ, vowel retractions is blocked.

(68)

/kən + ɚ/	*COMPLEX^{COD}	֍IDENT(bk)	*V$_{[-bk]}$ɻ	IDENT(bk)	☆MAX-N-IO/COD
a. ֍ kənɻ	*!				✓
b. ☜ kɤɻ		*!		*	*
c. ☞ kəɻ			*!		*

The tableau (68) analyzes interaction of vowel retraction and coda deletion[15]. (a.) preserves the nasal coda in the stem and is selected as the sympathetic candidate by the faithfulness constraint ☆MAX-N-IO/COD. It fails to survive due to the violation of *COMPLEX^{COD}. (b.) is the transparent candidate because it would be the most harmonic member without the sympathetic constraint ֍IDENT(bk). Since (b.) has a different vowel backness value from the sympathetic candidate (a.), it violates ֍IDENT(bk) and is ruled out. (c.) is the opaque candidate. The vowel backness value of (c.) is the same as that of (a.). (c.) does not have a complex coda. It satisfies both

[15] This subsection focuses on the phonological opacity. Only crucial constraints to the opaque processes are provided. Other constraints such as 'REALISEAFFIX, TEMPLATE, etc.' have been discussed in previous subsections and are not addressed here.

⊛IDENT(bk) and *COMPLEX^{COD}. The violation of lower-ranked *V$_{[-bk]}$ɻ is tolerable. Thus (c.) is selected.

(67d.-e.) involve vowel insertion and coda deletion. Similar to vowel retraction, vowel insertion[16] is also enforced by *V$_{[-bk]}$ɻ. Insertion is suppressed when deletion happens. This is a sympathy effect. The sympathetic candidate is selected by the faithfulness constraint ☆MAX-N-IO/COD because it maintains the nasal coda. The sympathetic constraint ⊛DEP-V-IO checks segmental correspondences of vowels between the sympathetic candidate and other candidates. The opaque candidate meets the requirement whereas the transparent candidate incurs violation. Vowel insertion is blocked by ranking ⊛DEP-V-IO above *V$_{[-bk]}$ɻ.

(69)

/ miŋ + ɚ/	*COMPLEX^{COD}	⊛DEP-V-IO	*V$_{[-bk]}$ɻ	DEP-V-IO	☆MAX-N-IO/COD
a. ⊛ miŋɻ	*!				✓
b. ☜ mjə̃ɻ		*!		*	*
c. ☞ mĩɻ			*¡		*

The tableau (69) analyzes interaction of vowel insertion and coda deletion. (a.) preserves the nasal coda in the stem. It is selected as the sympathetic candidate by ☆MAX-N-IO/COD. (a.) is ruled out due to fatal violation of *COMPLEX^{COD}. (b.) is the transparent candidate. It satisfies the markedness constraint *V$_{[-bk]}$ɻ. (b.) contains an inserted vowel which violates the sympathetic constraint ⊛DEP-V-IO. The violation is fatal and (b.) loses. (c.) is the opaque candidate. Its violation of *V$_{[-bk]}$ɻ is tolerable because the constraint is lower-ranked. As a result, (c.) becomes the output.

The constraint hierarchy that is crucial in the non-surface-true opacities can be summarized in (70).

(70) *COMPLEX^{COD}, ⊛IDENT(bk), ⊛DEP-V-IO >> *V$_{[-bk]}$ɻ
>> IDENT(bk), DEP-V-IO, MAX-N-IO/COD

[16] The reason that vowel insertion rather than vowel retraction occurs to high front vowels is provided in section 5.4.3 and will not be repeated in the current discussion.

5.5 Summary

In this chapter, I have examined the morphophonemic alternations in Xuzhou diminutive suffixation. I observed basic suffixation, vowel retraction, vowel insertion, vowel nasalization, coda deletion and coda contraction in the data. After discussing the merits and inadequacy of previous studies, I provided an optimality-theoretic account for the alternating forms. In addition, I discussed non-surface-true opaque phenomena in stems with nasal codas, and adopted the sympathy theory to explain suppression of vowel retraction/insertion under coda deletion.

Universal constraints and their interactions operate in Xuzhou morphophonemic alternations. The constraints and crucial rankings are summarized in (71) and (72).

(71) *Constraints in Xuzhou morphophonemic alternations*

	Markedness constraints
1.	REALISEAFFIX
2.	TEMPLATE
3.	*COD/V
4.	*COMPLEX^{COD}
5.	*COMPLEX^{NUC}
6.	*V_{NASAL}
7.	*$V_{[-bk]}$ɬ
8.	*i̱
	Faithfulness constraints
9.	IDENT(-cons)
10.	IDENT(bk)
11.	⊛IDENT(bk)
12.	MAX[+nas]$_{ŋ}$
13.	MAX[+nas]$_{n}$
14.	MAX-N-IO/COD
15.	MAX-*u*-IO/COD
16.	DEP-V-IO
17.	⊛DEP-V-IO

(72) *Crucial constraint rankings in Xuzhou morphophonemic alternations*

1. REALISEAFFIX, TEMPLATE, *COD/V, *i, *COMPLEX^{NUC}, *COMPLEX^{COD}, MAX[+nas]$_{ŋ}$, MAX-*u*-IO/COD >> *V$_{[-bk]}$-ʟ >> IDENT(-cons)

2. *COMPLEX^{COD}, ⊛IDENT(bk), ⊛DEP-V-IO >> *V$_{[-bk]}$-ʟ >> IDENT(bk), DEP-V-IO, MAX-N-IO/COD

3. MAX[+nas]$_{ŋ}$ >> *V$_{NASAL}$ >> MAX[+nas]$_{n}$

Chapter 6 Conclusion

In the present thesis, I have explored segmental phonology of Xuzhou Mandarin, and provided an optimality-theoretical account for the phonological generalizations. This chapter summarizes the main findings and arguments, and discusses the contributions of the current study. It closes the entire thesis by acknowledging the limitations in hope of improvements in future studies.

6.1 Main findings and arguments

Nine vowel phonemes are proposed. All are laminal oral vowels. The apical nuclei which are traditionally treated as "vowels" are classified to be syllabic approximants. They are considered as prolongation of the preceding consonants. This argument is supported by their articulatory properties and phonotactic behaviors. The nasal vowels are proposed to be realized from /VN/ combinations. Identification of the /V-/ phoneme considers the phonetic properties of nasal vowels, their phonotactic behaviors and the manifestation in diminutive suffixed words. Identification of the /-N/ phoneme appeals to the nasal rhymes in Middle Chinese and the parallel /VN/ patterns in modern Standard Chinese.

Nineteen consonant phonemes are proposed. Palatals are complementarily distributed with dental stridents, retroflexes and velars, and are logically possible to be variants of the three consonant types. Velars are selected to be allophonic with palatals because semi-onomatopoeic words and literary-colloquial readings show alternation between them. The velar nasal only occurs at the syllable coda position and does not form a minimal pair with other consonants. The velar nasal phoneme is proposed regarding its phonetic distance from the bilabial and dental nasals and its change under diminutive suffixation.

Co-occurrence restrictions on segments within a syllable are found between Nucleus and Coda, Medial and Nucleus, Onset and Medial or Onset and Nucleus. I have identified three phonotactic domains, namely the *rhyme* domain of 'Nuc+Cod', the *rime* domain of 'Med+Nuc+Cod', and the *minimal syllable* domain of

'Ons+Med+Nuc'. The domain distinction is consistent with my proposal for the syllable position of medial glides. I treat G as part of Rime, sister of the 'Nuc+Cod' combination.

I have considered that the labial co-occurrence restriction is less restrictive to the unmarked segment than to the marked segment. I have also shown that the backness co-occurrence restriction differentiates syllable constituents. The restriction works between the medial *j* and the front vowel nucleus when there is a consonant onset. But if a syllable has zero onset and the medial becomes the onset implicitly, the backness restriction does not apply.

The phonotactic generalizations are accounted for within the framework of OT. I have used the undominated markedness constraints to explain non-cooccurrence patterns in Xuzhou. I have also demonstrated that alternating forms can be realized by ranking markedness constraints above faithfulness constraints in order to achieve structural well-formedness. Phonological processes such as insertion, deletion or featural change are identified.

I have proposed that the diminutive suffix is a segment but not a floating feature because it can replace the coda segment in the stem instead of adding a feature to it. Besides, the suffix can fill in the nuclear position as an independent segment if the stem does not have a nucleus.

Segments in stems alternate in suffixed words. Front vowels change to central and the central vowel changes to back. The mid central vowel is inserted between a high vowel and the suffix. Oral vowels become nasal if the stem has a /ŋ/ coda, but it remains oral if the stem has a /n/ coda. The nasal codas are deleted but the /u/ coda is preserved through contraction with the suffix. /u/ in stems becomes rhotacized in suffixed words.

The morphophonemic alternations are explained by OT constraints and their interactions. Vowel retraction happens because there is a requirement for segments in the rhyme to agree in backness. Front vowels become central but not back in order to incur less violation to the faithfulness constraint of preserving the backness feature.

Coda deletion occurs under the pressure of no complex coda. The nasal feature of /ŋ/ is preserved in the nuclear vowel because the faithfulness constraint for the nasal feature of the velar nasal overrides the markedness constraint of no nasal vowel. On the contrary, the nasal feature of /n/ is missing because the faithfulness constraint for the nasal feature of the dental nasal is lower-ranked than the markedness constraint and it must be sacrificed to entertain the latter. Coda contraction is achieved under the force of two constraints. One requires that the suffix must be realized, and the other states that the /u/ coda can not be deleted.

The non-surface-true opacity is observed in suffixed words. When the stem has a nasal consonant coda, the processes of vowel insertion and vowel retraction are suppressed by coda deletion. I have adopted the sympathy theory within the framework of OT to explain the opaque phenomena. An inter-candidate faithfulness relation is built up as the sympathy relation. The opaque candidate does not undergo vowel insertion or vowel retraction. It is faithful to the designated sympathetic candidate that preserves the input vowel or keeps the backness value. Therefore, the opaque candidate is selected by the grammar.

6.2 Contributions

The current study can contribute to on-going projects and future research on Xuzhou Mandarin and Chinese dialectology by its achievements in the phonological system and segmental alternations.

The proposal of Xuzhou phonological system prepares the groundwork for the study of Xuzhou sound patterns in multi-syllabic words and in connected speech. It enriches the knowledge of Zhongyuan Mandarin. Subsequently, the findings in Xuzhou provide evidence for classification and delimitation of Chinese dialects.

Xuzhou segmental alternations that have been attested in other Chinese dialects give support to previous studies from a cross-dialectal perspective. The alternations that are first reported in Xuzhou would broaden the vision of Chinese segmental phonology and motivate further investigation.

6.3 Limitations and future studies

It can not be hoped that all issues in relation to Xuzhou phonology can be solved through one paper. Limitations of the thesis are presented for improvements in future research.

The scope of the data is restricted. Mono-syllabic words are the primary source of my study. In the literature of Xuzhou linguistics, filed reports of multi-syllabic words and connected speech are rare. Therefore, the fieldwork to collect data of multi-syllabic words and connected speech is called on in the future. The studies in these two fields will hopefully provide more varieties of sound patterns in Xuzhou.

A few constraints are invoked by the systematic gaps in Xuzhou and explained from the articulatory perspective. Although the language-specific evidence and the phonetic grounding are compelling, the lack of typological motivation weakens the justification to a certain extent. Not all constraints that have been proposed in the OT literature satisfy both the phonetic grounding and the typological motivation (Kager 1999:11). In the future study, I shall verify the constraints in other languages.

The sympathy theory is a development of the classic OT to account for phonological opacities. It not only recognizes the input-output faithfulness relation, but also proposes the inter-candidate relation. Although inter-candidate dependency is understood in parallel rather than serially (McCarthy 1999:349), the linguistic mechanism becomes complicated. Future endeavors can be made to improve the OT grammar in ideal hope of maximizing its explanatory power and minimizing the theoretical complexity.

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